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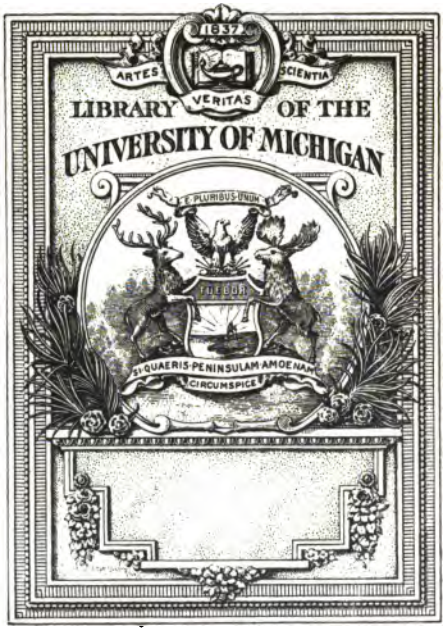
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From Prof. I. N. Dimmon

PRIMARY PHENOMENAL ASTRONOMY

FOR

TEACHERS AND GENERAL READERS.

☆ ☆ ☆

-BY-

F. H. BAILEY.

☆ ☆ ☆

NORTHVILLE, WAYNE CO., MICH.
1886.

THE LECTURER'S COSMOSPHERE.

Transparent, six feet in diameter. Patent allowed Dec. 9th, 1885, and covered by seven broad claims.

PRIMARY

Phenomenal Astronomy

FOR

TEACHERS AND GENERAL READERS.

HOW TO STUDY, and HOW TO TEACH IT.

BY

F. H. BAILEY,

Inventor of the Astral Lantern, or Panorama of the Heavens; and the Cosmosphere, or Miniature Universe.

"That heaven's great secrets may lie hid no more,
And man, instructed, gratefully adore."

—*M. Manilius.*

NORTHVILLE, WAYNE CO., MICH.

1886.

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PREFACE.

The reader unacquainted with our work, and doubtful whether its claim upon attention is well sustained, is invited to examine both source and character of a few endorsements. See page 98. The letters there cited speak principally of its platform presentation. A few leisure hours while at the factory superintending the manufacture of the apparatus herein described, have furnished opportunity for preparing this brief exposition.

If only a "half-hour" can be spared for its perusal, read Chapter I., a few pages at the beginning of Chapters II. and III., and more or less of Chapter IV. If interested chiefly in the instruments, they are discussed, together with a method of using, in Chapter IV. The main portion of Chapter III. and last few pages of Chapter IV. show something of the close connection existing between our subject and various poetical, classical and historical studies.

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Introduction.

The little astronomical knowledge obtained in connection with the study of geography is not only the first, but *all* that the majority of pupils get in school, as it is the minority that reach the high schools where astronomy is taught. Hence the simplest facts of astronomy should be taught—and well taught—in connection with or previous to geography. They present strong claims by reason of their fundamental character and practical value, but we believe their strongest claim rests in their adaptability as a means of intellectual, moral and religious training; of moral and religious training an indirect means, but of intellectual training a direct means of the highest value. Their high value does not appear, however, when taught in the ordinary text-book method. The simplest elements of theoretical astronomy, separated from the phenomena, even when understood, are soon forgotten; moreover, scientific instruction thus imparted, is but slightly educative, and sometimes actually the reverse, hindering instead of helping mental growth.

When teaching was conducted on the principle that the child's mind was an empty dish to be filled with information, that the pupil was to be made a dictionary or walking encyclopedia, astronomy received its share of attention in the common schools; but when it came to be understood that teaching, in order to be educative, must follow the laws of natural development, and that those laws demand that science should be taught by object lesson—phenomenally instead of theoretically—astronomy lost the attention it had received. It was thought that the difficulties were so great in bringing the pupil into actual contact with the objects of the science, that it must be left for the higher schools to teach theoretically, and that the child must be taught arbitrarily the facts of "Astronomical Geography." But the new education says that no scientific fact should be taught the child in that manner; that he should be brought face to face with nature, and by observing the different individual phenomena, be led to discover for himself the general laws that underlie them. Consequently, he should reach the conclusion that the earth is a sphere, in the same way that mankind reached it,—by the observation of the movements of the heavens. This is the correct process for scientific study based in the nature of things; and science thus studied affords the best possible mental discipline. The natural inquisitiveness of the child finds its counterpart in the objects of nature. They were made to fit each other. The stars hung in heaven are as well adapted to his mental wants as the fruit hung upon trees to his physical. The study of nature is pleasing to him. It is his great desire to see and to know something about what he sees. He is

naturally hungry for knowledge, but it is knowledge of things he desires; and it must be obtained directly through the senses in order to be palatable or nourishing. The child's "Let me see," and "What is it?" are nature's hints of "How to Teach."

Not only is elementary astronomy best taught by this method, but it is one of the best of the sciences, if not *the best*, with which to teach the method. It has many advantages over the others, with but *few* disadvantages. It is easily adaptable to the widest range of circumstances,—can be commenced at any age and pursued in a scientific manner, more or less rapidly, as long as desired. It provides the pupil, free of expense, the grandest panorama the human eye ever beheld,—one which contains thousands of beauties for him who has learned them, never seen by the untaught and unobserving eye. For the purpose of overcoming the few difficulties that exist in applying the object method to "Astronomical Geography," and elementary astronomy, the writer has made two inventions, which have been well received by his fellow teachers; and for the purpose of calling more general attention to his application of the method, this little book is written. As it may fall into the hands of some who have not studied the "Science of Teaching" by this method, he has introduced a few general principles in connection with his application of them to the subject of astronomy, trusting in the lenity of those already familiar with them.

Practical teachers are respectfully requested to examine the method and put it to the test. Suggestions from them will be thankfully received, especially such as may aid in the production of an elementary book that shall

meet the requirements of the case. Possibly only a Teacher's Aid will be wanted, for by this method, to a far greater extent than by the old, "the teacher is the school."

Respectfully,

Northville, Mich., 1886. F. H. B.

I.

Methods of Studying Astronomy.

There are two general methods by which the study may be pursued, the Theoretical and the Phenomenal, each admitting of sub-methods. The theoretical, which is the one ordinarily used, makes the study of theory first and principal, either omitting phenomena entirely, or assigning it to a secondary and insignificant place. The phenomenal reverses the order, presenting phenomena first and theory last.

By the theoretical method, either the theory is pursued to the end without regard to phenomena, and then more or less of the phenomena considered and explained by means of the theory; or, phenomena is introduced from time to time in the course of the study of the theory.

By the phenomenal method, either the phenomena is pursued to the end without regard to theory, and then theory brought forward to explain the phenomena; or, theory grows in the mind of the student in connection

with the phenomena more or less rapidly and accurately according to circumstances.

This latter method, which is far the best, may be degraded to the level of the others by the manner in which it is used. That is, the teacher may do the observing and theorizing for the pupil, and allow him simply to memorize the results; in which case only the teacher receives the full benefit of the method; or the teacher may lead the pupil to pursue the study himself, in accordance with the developing method; in which case the teacher will observe for himself, but will not give the results of his observations to his pupil. He will simply open the book of the heavens at the best page to commence, and call the pupil's attention to that page, and arouse his desire to see what he can discover therein. The pupil is taught how to observe, guided along the proper course that he may see the phenomena in that order in which they will best conduce to his mental growth, and that of his astronomical theories. The pupil learns "how to do by doing," how to observe and how to theorize by observing and constructing his own theories. His theories will at first be very inaccurate, being the results of limited observations and very limited powers of generalization, but they will be steps in the right direction, and as he increases his observations and gains mental strength, he will approach nearer and nearer to the exact facts of the science.

If the pupil commences this study when quite young, his generalizing and theorizing will be very slow, and considerable time should be taken for observation and study of phenomena. That is, the time taken should reach through years, and the child, having his observa-

tions directed along the proper course, should become perfectly familiar with every visible part of the celestial sphere and its general movement. This familiarity can be gained with little or no more time used in actually looking at the heavens than is spent by the majority of people, who, through want of a little assistance, never become acquainted with more than the Great Dipper and North Star, and perhaps Orion and the Pleiades.

As the pupil progresses in the study of the heavens, his mind increasing in strength and power of generalizing, he begins to reason about what he sees and to form theories to account for the movements he detects; for it is impossible to become familiar with the appearance of the heavens itself without discovering its apparent motion, and having the curiosity aroused thereby.

He very soon perceives that what at first appeared to be a hemisphere resting on a flat earth, in the center of which he lives, is a sphere revolving about the earth, with only half visible at a time. He will at first discover that this sphere revolves daily about the North Star as a center; but continuous observation leads him to the more accurate conclusion that it completes a revolution in a little less than a day, and that the North Star is not at the centre of the motion, but itself revolves in a small circle as frequently as the rest of the stars in larger ones. As he very early in his study discovers motion, he also discovers that the stars are fixed relative to each other. At first he thinks they are all fixed, but as he becomes familiar with more and more of the heavens and reaches the zodiac, he finds a few exceptions to that general law.

The moon will be the first discovered wanderer; but

the number will increase one by one, till it reaches the seven visible to the naked eye. The discovery of them all, and their various movements will require considerable time and very careful observation; but the *primary phenomenal astronomy*, which we are advocating as a foundation for *elementary theoretical astronomy*, and the study of day and night, zones and seasons, tropics, polar circles, etc., does not require that the complex movements of the five planets be understood, or even that the planets be discovered. It does require, however, that the annual movement of the sun, from west to east, be well understood and his path located. But this movement would never be detected by observations of the sun, separated from those of moon and stars. His varying daily position would show that he moved northward and southward, but his easterly motion around the heavens would never be discovered. With the moon, however, *that* motion is easily detected, as more or less of the stars along her path are usually seen, and her motion is so rapid that, when near a bright star (or faint one if opera glass is used), the motion itself is visible; but when this is not the case, her change of place among the stars from night to night, or even during a few hours, is so great as to be easily detected. As she makes this journey once a month entirely around the heavens, in opposite direction to that of her daily motion and that of the sphere as a whole, it is seen that her monthly movement is not parallel with her daily, and that half of her path is north of east and west, and half south, hence the reason she varies her point of rising and setting and her daily motion. And when this same, though slower, variation of sun is detected, it is

referred to the same cause—a movement along a path similarly located in the sphere.

Though the second or yearly movement of the sun and the position of his path—the most essential thing in the heavens to have well located—are reached through the study of moon and stars, observations of his daily movements need not, in fact ought not to be deferred till this time. They should be commenced about the same time with those of the stars. They need not be made daily—weekly is perhaps often enough—but should continue through a year, or till the pupil has a clear conception of them. He is taught, if he does not already know, the division of the circle into degrees, and is told to divide the horizon into quarters, and to commence at the east and west points and reckon 90 degrees each way to the north and south points. Then he is to observe how many degrees north or south of east the sun rises, how many north or south of west he sets, and how many he is above the southern horizon at noon. He should also observe the time of his rising and setting, and the increasing or decreasing length of both day and night, and should keep the results of his observations in tabular form for reference aud study. Some will make and keep them much more accurately than others. An inventive genius will make an instrument out of a few pieces of wood with which to measure the angles. All will watch shadows and sunlight on the floor with more interest than previously, and marks will be made to help observations. Pupils of considerable age and advancement will perceive what the sun's daily movements are for the entire year after making observations for portions only, perhaps for the

three months from sun at either equinox to the following solstice, or the reverse.

As the pupil discovers for himself the annual motion of the sun, he also discovers that there is some connection between that motion and the slightly varying position of the stars, as seen night after night; and finally he perceives *clearly* why the northern quarter of the heavens is a different side up the same time of night at different seasons of the year, while the southern, eastern and western quarters present entirely different objects. By this method of study the "daily acceleration" of the stars is not only discovered, but its cause, instead of the term, and its definition being learned arbitrarily as by the common method. We will suppose that the pupil has become quite familiar with the constellations, except those lying so near the south pole that they are never seen at his latitude; that he is perfectly familiar with their varying positions for different times of day and year; that he has the paths of the sun and moon located with considerable accuracy in the sphere, and that he sees clearly how the varying daily movement of each is caused by its changing its position among the stars along a path not parallel with the "daily" motion of the heavens, but constantly approaching either one or the other pole. He has noticed one or more stars (morning or evening) shifting position in a manner similar to that of sun and moon, either in the same or opposite direction, but he has not become familiar with their movements. This will require time, and instead of waiting till it is accomplished, he should endeavor to see, from different positions on the earth, the movements thus far learned. He should, in imagination, transport

himself to the earth's equator; and from Quito, for instance, watch the movements of the sphere revolving about an axis lying in the plain on which he stands, the poles of which lie in his northern and southern horizon. Remaining there a year, he sees the movements of the sun rising in the east and setting in the west no more frequently than at home, though days and nights are of the same length throughout the year. He sees that, though the sun changes his place of rising and setting in the same direction for each season that it did at home, it always rises at right angles with the horizon, and does not move so far along it. The arc between extreme northern and southern points being but little over one-eighth of the circle, half lying north and half south of east, whereas, at home (if that was in the northern part of the U. S.) the arc was about three-sixteenths of the horizon. Having seen the sun and star phenomena at the equator, he travels northward and perceives the heavens to change position by turning on an axis, the poles of which occupy the east and west points of the horizon. The northern heavens rises, and the southern sinks one degree for every degree he travels, till on reaching the city of Mexico, the north pole is about 20° above the horizon, and all stars within that distance of it revolve "daily" without rising or setting. Day, as distinguished from night, varies in length from about 11 hours in mid-winter, to 13 in mid-summer; and the sun occupies in rising and setting a larger arc of the horizon. Stopping at latitude 23½° the sun is seen to be exactly in the zenith at mid-day, on or about June 21st, and midway between southern horizon and zenith, on or about December 21st. Stopping

at New Orleans, the north pole is 30° high; mid-winter day about 10, and mid-summer, 14 hours long. At Philadelphia north pole is nearly one-half way from horizon to zenith; midwinter day about 9, and mid-summer, 15 hours long. Continuing northward the pole rises, the heavens revolve more and more nearly parallel with the horizon, difference between length of winter and summer days increases, till, on reaching the arctic circle, mid-summer day becomes 24 hours, and mid-winter 0; the sun has continued to use more and more of the horizon for rising and setting purposes, till now he uses all of it, and occupies about the same place in mid-day in in mid-summer that he did at mid-day in mid-winter, when seen from the stop made in Mexico, 23½° north of the equator, viz: A point about half way from southern horizon to zenith.

To see those movements, however, from different parts of the earth with the mind's eye, unaided by the physical, is almost impossible for the majority. Pupils with good imagination, who have mastered the phenomena at home and reached the conclusion of the sphericity of the earth, and that the axis of the celestial sphere is the axis of the earth extended, will transfer themselves from equator to arctic circle, and see the simplest phenomena to which we have referred. They *may* also be able to make a journey to the north pole, and there see the parallel movement of sun and stars; but we believe (and our belief is based on some experience with both pupils and teachers) that not one in a thousand will be able to stop at intermediate points between arctic circle and pole, and give an explanation

even approaching accuracy of the most interesting celestial phenomena there seen.

Pardon us, "gentle reader," for not continuing that journey in this chapter; you may not be that one in a thousand. If you are, however, stop a year at Fort Conger, Lady Franklin Bay, and see what the sun's movements are, and determine how many times he rises and sets. All the fact you need is the statement made by J. W. Randolph in his account of the Greely Expedition, that "the sun sailed away for the apparently *never ending night* on Oct. 15, and was not seen again till Feb. 26, when he just showed his face, departing again almost directly." What variations in length of day between one of only a moment and one of over four months! Of course your results will not correspond with Mr. Randolph's record, unless the effect of refraction, which is very great in the arctic regions, is taken into account. In our study of phenomenal astronomy the effects of refraction are not at first considered.

We have endeavored in this chapter to give a few points of the developing method of studying the heavens, and have not attempted to show how the discovery of one phenomena leads to another, or phenomena to theory; but our *astronomical* readers at least, will see that they follow each other in the order outlined, as inevitably as the conclusion that the earth does not extend indefinitely in every direction, follows from the study of the movements of the heavens.

II.

Study of Constellation Figures.

In order to study the movements of the heavens, the pupil must be sufficiently familiar with its appearance to recognize the different stars whenever and wherever he sees them. As this is impossible to any considerable extent through their individual differences, it must be done by means of their irregular arrangement; hence, the first step should be that of becoming acquainted with the different groups of stars and their relative positions in the sphere. For this purpose each pupil might map the heavens to suit his own fancy; and such a method would have some advantages. He might put together neighboring stars, and form groups according as he fancied he saw resemblance to familiar earthly objects; but he could not readily refer another to any part of the heavens except by means of a common system of grouping. There is such a system which has come down to us from the nations of antiquity; and it is a good one, though objections have been raised against

it, and attempts made to displace it with others. It cannot be superseded, however, for having become incorporated into the best literature, both ancient and modern, it has become an inheritance of the human race, and will last as long as our civilization.

In mapping the heavens to-day we use, in addition to the constellation figures of the ancients, about as many of modern invention, made in imitation of the ancient, since the invention of the telescope and the navigation of southern seas. In these modern figures, however, we have but little interest, for literature has but few references to them, and they are of but little value to the student, as they occupy either the circle of the heavens about the south pole—not seen from our middle northern latitude—or places between ancient figures where there are no bright stars. But the constellations which have come to us from more ancient peoples through the Greeks, "who made the whole heavens into a moving panorama of the grandest deeds and highest poetry," should be learned; not only on account of their great aid in the study of astronomy, but because of their intimate connection with literature, and their intrinsic value. For illustration of their utility in the ordinary walks of life, we beg pardon for introducing a personal experience:

Walking along a narrow street of a strange city one evening, a companion asked, "Can you tell the direction we are going by the stars, without seeing the North Star or Dipper?" Almost directly in front of us and about an hour high was the Eagle, with the straight line running through the three stars, Tarazed, Altair and Alshain nearly parallel with the horizon; consequently

we replied, "We are going directly west; there is the Eagle." "But," said our companion, "if the Eagle sets in the west it rises in the east, and you must know just where it is all the time in order to be able to tell the direction by it." "Not so," was the reply, "for when seen in the east the Eagle is flying perpendicular to the horizon, instead of parallel with it as now. It differs from the Twins in that respect, for they rise lying down and *sit standing."

But the Eagle and Twins are not the only figures that—seen from our latitude—change their relation to the horizon in passing from the eastern to the western. The Swan rises in the northeast, parallel with the horizon, apparently flying eastward, but sets head first, with the Northern Cross (the upright of which follows the neck of the bird) standing erect. The Dolphin rises but little north of east, swimming along the horizon towards the north, but sets tail first, swimming towards the zenith; while the Northern Fish—of the constellation Pisces—does exactly the reverse in both rising and setting. Andromeda, the Chained Lady, rises lying down, but instead of setting standing up, as do the Twins, goes down head first. Boötes, the Herdsman or Bear Driver, follows the example of the Twins both in manner of rising and setting; while Hercules, though neither rising nor setting perpendicular to the horizon, comes up feet first and goes down head first. In fact, every constella-

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*I suppose we must follow the more common custom of speaking of celestial bodies as setting. It does not seem quite so inelegant to speak thus of the Twins or of the Sun, even when personified; but when we come to the celestial Swan, the beautiful Andromeda, and Cynthia—the lovely goddess of the night—to be compelled to say that they set when a common barn fowl is permitted to sit, arouses our indignation, and we do it with a protest.

tion in the heavens varies its angle with the horizon during its entire revolution, thus revealing its direction from the observer. Therefore, a single constellation, seen through a window, or between the buildings of a narrow street, or through a break in the clouds, makes known the points of the compass; and just as easily does it also reveal the time of night.

The study of the constellations, whatever the age of the pupil, should commence with the Great Bear and follow the same order through the northern circumpolar, after which the order will depend upon the season of the year. In connection with the study of the figures themselves, more or less of their literature, according to circumstances, should be learned, or at least read. With young children, progress in constellation tracing should be slow, and made interesting by the use of the prettiest mythological stories and the many neat little star rhymes, which not only please, but help the memory. George Herbert's line, "A verse may find him who a sermon flies," is especially applicable to children. With older pupils progress is more rapid, but some mythology and poetry should be introduced; perhaps only readings from the many poets who have drawn inspiration from the heavens. Aratus and Manilius furnish the largest amount of such literature; but Homer, Hesiod, Ovid, Virgil, Job, Shakespeare, Milton, Tennyson, Longfellow, Lowell, and scores of others have made references to the constellations, most of them *very beautiful to him* who can appreciate them, but incomprehensible to *him* who has no knowledge of the figures or their place in the heavens.

To be sure this mythological and poetical study is

not astronomical science, nor is it developing the reasoning faculties by the scientific method; but it is laying the foundation for literary studies, and lies at the very bases of the sciences of history, "sacred and profane." "Mythology is the basis of history," says Bryant. Some time ago the Germans discovered that the place to commence teaching history is with Grecian Mythology. We give an extract from a letter by a correspondent of the Boston Journal, which not only gives the fact but the method by which it is done:

"History."

"Do you have any text-books?"

"None at all," said the teacher. "This is the youngest class in the study."

"And how old are these little girls?"

"They average nine years," she replied.

There must have been about forty bright looking little children sitting with hands clasped and waiting orders. They seemed too young to comprehend history, so I ventured to say:

"I suppose you begin with some simple tale of Germany?"

"Oh, no."

"Perhaps a bit of local history?" I suggested.

"As far as possible from it," she answered.

"But—where then?"

"*Grecian mythology!*"

And turning to her class she asked, "Now, what did you learn last week?"

"Baby Hercules and the snakes," said little Theresa Somebody.

"And Theresa must tell it to the school," said the

teacher. So Theresa began, and with sparkling eyes, related the marvelous tale; how Hercules was born to Jove of an earthly mother, how Juno plotted and tried to destroy the youngster, how she sent two dreadful snakes, and how Baby Hercules seized them in his chubby little hands and *cr-rushed them to death!* And even as little Theresa told the tale, she gathered up her own chubby hands, and closed them with a grip, as if the snakes were really in them.

Theresa failed now and then to give, perhaps, the exquisite sharpness of detail with which the story had first been told to them, but forty critics were glaring at her, and forty pairs of listening ears were waiting for the slightest chance to criticise; so that nothing was allowed to pass till it was *just* right, and Theresa had repeated it all over to the veriest satisfaction of the other children.

"To-day," said the teacher, "I shall tell you something *v-e-r-y* wonderful. I shall tell you how, so long, long ago, there sailed away from Greece a band of men in quest of a golden fleece." And she proceeded to tell them of Argos, of Jason and his followers, and the remarkable journey and adventures they met with in their wandering after wealth. She did not relate it in broken parts. First she told the tale simply, on through it all to the end. The attention was even painful. The enraptured little maidens hardly dared to wink for fear of losing something; and there, in spite of the picture they made, they sat with red lips not merely parted, but stretched wide open in a perfect dream of surprise. And then she returned to the beginning and repeated the first proposition in the tale, which the school repeated

after her. To this she added the second, and then the third, and then the fourth. Finally, when the story was completed, she said, "Now, will Mädchen Rosalie rise and tell us all she knows about it," and Rosalie stood and told it fairly from end to end.

"Will Mädchen Bertha begin it?"

Mädchen Bertha complied and finished the first sentence.

"What are the faults," asked the teacher; and twenty hands went up like lightning.

"She mis-pronounced Argos."

"She left out a word."

"She began wrong."

"And she forgot to say 'so long, long ago!'"

Thus corrected, Bertha rose again and repeated it without a fault. Others then followed Bertha, failing, catching up the corrections, repeating again and again under a shower of criticisms and rightings, until the whole story was learned and the school at last recited it in concert. And yet it was not a parrot concert, for when I asked a little girl to tell me the story all alone, she rehearsed it in her own childish language, but in a manner so pretty and simple that I knew it was her own, and that the story had lodged very firmly in her mind.

It is one of the happiest conceptions in German education that the study of history is introduced through this beautiful, enchanting mythology. It is not a fortuitous, unlabored scheme. Everything and every method possible has been tested by the Germans to reach some way of presenting history at once to the children in an easy, attractive light. They have at last hit upon mythology as a starting point. To say that it was a

success does not express the wonderful grasp it has taken upon the German children. Mythology, though not strictly history, is yet so woven into the life of early peoples that its study is a necessity. It is, perhaps, a stage of history bearing to the real what dreams do to facts. It is a sort of wonderland where nations have had their fancies, their poetry, their religion. Children love wonderlands. The Germanic races, especially, delight in soaring off from their stern, bald duties to fairyland and mystery. No children are so fond of it as the Anglo-Saxon and the German. They live, as it were, in a kind of unreality; their minds are forever flitting away to the magical, the wonderful, the supernatural. Mythology, therefore, appeals to them through the strongest sympathies of their little lives. It comes to them at a time when that wicked giant Doubt has not yet entered the gates to chill the imagination and spoil the pictures of legend and childhood. They listen to the tales as if the very air before them were peopled with the forms of gods and godesses; as if the very tales were acts of the moment; as if land and water and all earth had been transformed, and life itself had yielded to the fairy wand. Older people do not know the charm of mythology. They doubt, they reason, they speculate, they philosophize. They find in the old Sagas, be they never so extravagant, some deep philosophy which shatters the whole beautiful fabric, and reduces it to a few cold, gray facts that may be passed around in a college class room like geological specimens or the vertebra of a rare monkey. The charm is gone, and men who read mythology, whether they are conscious of it or not, rob it of the unreal and the wonderful. They find an

intellectual enjoyment, but they find no thrilling happiness as children do. To men it resembles a philosophy with a lost key; to children it resembles that general sentiment in which they live and dream and have their being.

Mythology is now generally introduced throughout the schools of Germany. In the higher schools for girls, in gymnasiums, in middle schools—everywhere do the children hear of god-like Achilles, and Juno, the queen of the gods. Even in the "Volk" schools the teachers sit and tell the old Grecian tales to ragged elves, who wonder at them no less than would the children of nobility. In the higher schools for girls I have heard scholars of only nine or ten years of age recounting the siege of Troy, telling with wonderful zest all about the Wooden Horse, Achilles, Ajax and the rest; relating the Twelve Labors of Hercules and the Voyage of the Argonauts."

If the Germans are correct in making mythology the basis of history, as results seem to prove beyond doubt, how much better it would be to present with the stories of the "Labors of Hercules" and the "Voyage of the Argonauts" the star pictures of the same. Then, by the law of association, the recurrence of a clear night would enable us to renew our youth from time to time, by presenting us with a picture gallery filled with those heroes and heroines of the *youthful* race about whom we learned in *our* youth.

Sir John Herschell complained that "the heavens were scribbled over with interminable snakes;" but snakes, or serpents, are interminably interwoven with the earliest myths of the human race, and we believe

with Anderson, that "the myth is the oldest form of truth," and with Bancroft, that "every myth has a meaning." We must study these figures that have occupied the heavens from prehistoric times, if we would go back to the earliest history of the race. But aside from their usefulness in the study of astronomy, and the enthusiasm with which children learn them, we think that the strongest argument for the early study of the constellation figures rests in the fact of the very frequent references to them in literature, and the consequent necessity of knowing them in order to appreciate many of the finest passages of the best writers of every age and language. For a few illustrations of this fact, see latter part of the following chapter.

III.

Hints for Teaching Astronomy.

The fundamental principle of this method is self-teaching. The pupils are to be their own, or rather nature is to be their teacher. The living teacher has work to do, but it is not that of "stuffing." He simply directs his pupils where, and teaches them how to observe; and when they reason incorrectly, puts them on track of the phenomena that will correct their errors. While he is at first *useful* to his pupils, he so teaches that in the end he may become (as a celebrated French teacher said he aimed to make himself) *useless* to them. This he does by teaching them to walk, and allowing them to do so until they can run alone; they will fall occasionally, but will need little or no help to get upon their feet again.

We purpose giving, in this chapter, a few hints on teaching astronomy orally. The teacher, imbued with the spirit of the developing method, and acquainted with the heavens, will very readily adapt himself to his

circumstances. We will suppose that he has an intermediate or grammar grade of pupils. To assign the first lesson, if he has no hour set apart for oral work, he takes a few minutes just before the close of school some clear day that promises a starlight evening, and asks the question: "How many know the stars called the Great Dipper?" He will find some who do.* He then calls for descriptions of it. The pupils express various opinions about its exact shape, number of stars composing it, its position—that is, direction, height above horizon, side up, etc. The teacher very carefully avoids settling any of these questions, or giving his pupils any information they can obtain for themselves; but if endowed with the first qualification of a successful teacher, he has converted the school into an amateur Scientific Association. That very evening will see embryo astronomers making their observations; and the next day will see them comparing notes on the playground; for study is play when pursued by the natural method. When the oral lesson hour comes, not only are the questions of yesterday answered by the pupils themselves, but others raised by them to be settled in the same manner. Genuine *knowledge* was obtained the first evening by the best possible method—*observation;* and knowing something about the lesson the pupils can talk about it, and are anxious to do so; but their first attempt reveals the fact that they need names for the individual stars in order to tell readily what they know.

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*While making announcements of lectures, the writer has asked that question in more than a thousand schools of all grades, from primary to college, and always above the primary found more or less who were partially acquainted with the cluster.

The teacher gives them the first seven letters of either the English or Greek alphabet; better the Greek, for by them are the stars known to astronomers of all nations, and the same are applied as given names to the seven brightest stars of every constellation. They are α, β, γ, δ, ε, ζ, η, and are pronounced alpha, bata, gamma, delta, epsilon, zata, ata; and applied in order from right to left, when the dipper is exactly right side up.* A few pupils are allowed to represent the Dipper on the black-board, and others to criticise shape, position, etc. Probably some saw the faint star very near ζ, if so, have it represented; if not, do not tell which star it is near, but that it is called the Tester, because it is a test of fairly good eyesight to see it. It is also called the Rider, because it seems to be riding the star it is so near. (That evening the pupils will be testing their eyes by it, and the next day will give its position correctly.) Ask if any know of other names for the Dipper, or if it looks like anything else to them. Perhaps there is an English boy in school who will say plow or wagon. Tell them it is known in Great Britain by those names, and very many ancient people called it a chariot. In Shakespeare it is called King Charles' Wain, or Wagon; in France, Davids' Chariot; by the ancient Gauls, Arthur's Chariot.

One more night at least should be given to the Dipper, as the pupils may not all have studied it, probably but few carefully, and several observations are

*The popular names of these stars in the same order are Dubhe, Merak, Pheeda, Megres, Alioth, Mizar and Benetnash, or Alkaid, and of the Tester near Mizar, Alcor. More about star names, their origin, etc., will be given in a succeeding chapter.

necessary to fix its exact form in mind. Give time for the interest to become general; what some have seen and reported others will look for. They will discuss comparative distances between the stars—α and δ are twice as far apart as α and β, etc.; also comparative brightness—δ is not as bright as the rest of the Dipper, if it was eighteen centuries ago when Manilius wrote—

> "Seven equal stars adorn the Greater Bear,
> And teach the Grecian sailors how to steer."

Induce the pupils to observe as carefully as they will, and report results; but be very careful in questioning them not to anticipate their discoveries, and do not crowd them too fast. Make haste slowly. Nature is the teacher. Watch her method and see the intellectual powers grow under her instructions. As with the soldier, so with the teacher, he can sometimes serve his country best by standing still and watching.

Not many observations will be made before the motion of the Dipper, or at least its change of position relative to the horizon will be discovered. If necessary, hint to the pupils that they can invent some way to detect what that motion is. They will probably sight along the side of a house, or set a straight stick so as to point to a star, and leaving it for a time, return to discover not only direction, but amount of motion; but will not at first perceive it to be circular. Finally, however, nature will tell them,—in answer to their inquiries,—that it is circular and "daily." *Don't you do it. Don't* do anything to *rob* them of the *benefits* of making *such discoveries.*

Perhaps by this time show the pupils some maps of

the heavens, containing both stars and constellation figures; and tell then how the ancients, so long ago that nobody knows when, put such pictures in the sky, and how the different parts of the heavens are now called by the names of those men, animals, birds, fishes, etc. Give them each an outline picture of the Great Bear, containing the Dipper stars and the next brightest,—the seven in the feet, two in each of three feet, and one in the other; the one in the nose, and the few others in body and legs. Such a map, of any desired size, is easily reproduced from a star atlas, by means of a pantograph, and any number of copies made by lithogram or hectograph.* With such a map the pupil easily traces the Great Bear in the heavens, for it is not long since he saw a horse in a stick of wood, or since a shawl rolled up was to her a veritable babe; and the pupil will not make the mistake of many grown people, who ask if such animals are "really seen in the heavens with a telescope." No need to tell the child that he only "plays he sees a bear." But the bear he "plays he sees," he will always recognize, and it will be a friend to him throughout life, and sometimes a very valuable one.

On receiving their maps the pupils will detect something apparently wrong about the pictures, and be amused thereby. They have seen bears, or pictures of bears, enough to know that they have not such long

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*We have used the more expensive "Papyrograph Press" for printing students' maps, also the "Electric Pen;" but commend the gelatine process as being not only good, but very cheap,—an entire outfit costing but a dollar or two. No teacher who knows the value of such work will be without a reproducing process of some kind, good not only for maps and pictures, but for circular letters, programs, etc. The Pantograph, any one can make with a few sticks and screws from the illustration in Webster's Dictionary.

tails. Don't be afraid of a laugh in the school-room at the proper time, and now is the time for a good one. Tell them that probably whoever lifted the bear up to the heavens, laid hold of it by the tail, and the bear was so heavy and the distance so great that the tail stretched out that much. At any rate that it is always so pictured, whatever its cause. Or still better, before explaining the long tail, give them a little talk on Grecian Mythology, telling about the old belief in many gods, and giving in condensed form the Greek story of the origin of the Great Bear,—how it once lived upon earth, but Jupiter reached down and lifted it up to heaven. Then give them the reason for the long tail in the quaint old English of Prof. Thomas Hood of Trinity College, who wrote on the "Celestial Globe" in 1590.

"Scholar:—I marvell why (seeing shee hath the forme of a beare) her tayle should be so long.

Master:—Imagine that Jupiter, fearing to come too nigh unto her teeth, layde holde on her tayle, and thereby drewe her up into the heaven; so that shee of herself being very weightie, and the distance from the earth to the heaven very great, there was great likelihood that her tayle must stretch. Other reason know I none."

During the few days given to the study of this important constellation, the pupils all trace it in the sky, and report their discoveries. If the study is commenced at the beginning of the school year in September, the Bear is,—during the evening,—nearly erect, and near the horizon between north and north-west; the handle of the Dipper, or "tayle" of the Bear, pointing to the bright star Arcturus, one or two hours high a little north of west.

Some of the literature of this constellation should be given, or read in connection with the scientific study, but should not be allowed to anticipate discovery; as that would interfere with the proper development of the mind, by doing for the pupil what he must be allowed to do for himself; nor would he enjoy it as well as after he knows the facts on which it is based. Commence with the striking (hence easily remembered) rhymes of the old English sea captain. Give first the one which numbers the ancient constellations:—

"The army of the starry sky
Declares the glory of God most high;
Seen and perceived among all nations
In eight and forty constellations."

Then the one which tells correctly where to commence:—

"He who would scan the starry skies,
Its brightest gems to tell,
Must first direct his mind's eye north,
And learn the Bear's stars *well*."

But do not give the next, which tells why we should commence there, till the pupils have discovered why; ask the question, however, when second rhyme is given, and leave them to discover that—

"Where yonder radiant hosts adorn
The northern evening sky,
Seven stars, a splendid glorious train
First fix the wandering eye.
To deck great Ursa's shaggy form,
Those brilliant orbs combine;
And where the first and second point,
There see Polaris shine."

Do not read to them the grand inspiring poem by Henry Ware, Jr., till they have discovered—

> "With what a stately and majestic step
> That glorious Constellation of the North
> Treads its eternal circle! going forth
> Its princely way amongst the stars
> In slow and silent brightness."

Let them first discover, that they may the better appreciate the fact, that—

> "The other tribes forsake their midnight track,
> And rest their weary orbs beneath the wave;
> But she doth never close her burning eye,
> Nor stay her steadfast step. But on, still on,
> While systems change and suns retire, and worlds
> Slumber and wake, her ceaseless march proceeds.
> The near horizon tempts to rest in vain.
> She, faithful sentinel, doth never quit
> Her long appointed watch; but, sleepless still,
> Doth guard the fixed light of the universe,
> And bid the North for ever know its place."

When the Pole-star is discovered to be the "center" of the "daily" circular motion of the Bear,—and perhaps before,—another map should be given the pupils. "—— School Star Map, No. 2." This one contains both the Bears and the Dragon. The Little Bear is seen to resemble the Great one in containing a dipper, and having the handle of it for a tail;—the Pole-star being in the end of it. The seven stars of the Little Dipper are about all that can be readily seen of the Little Bear, and they are not so easily found as the Great Dipper, for only three of them are bright. When it is discovered that the Little Bear revolves daily by the end of its tail, some pupil remembering the Great Bear's tail

story, will probably suggest that the daily motion is what has stretched its tail to such an unnatural length. The Dragon,—or crooked serpent of Job,—is easily traced in the heavens; commencing with the bright stars in its "lozenge-shaped" head, and winding round between the Bears to the faint one in the end of its tail, mid-way between the head of the Great Bear and the Pole-star.

The literature of the Bears and Dragon is almost inexhaustible. The teacher will make selections to be learned or read. Pupils might search the library for references, or rhetorical exercises be based upon them. This chapter contains only a few of the hundreds that might be given.

The Captain's rhyme, which gives the names of the Pole-star Pointers, is—

"Where Charles' Wain adorns the sky,
If Merak you would know;
The Pole-star led through Dubhe's light,
Will mark it just below."

Below, or south in the heavens, is always in straight line from the north pole, (say from the Pole-star till it is discovered that it is not exactly at the pole). West is the direction in which the stars are moving. The head of the Great Bear is always west of the tail. For the popular name of β in the Little Bear, and the scientific name of the constellation itself, the following Captain's rhyme:—

"Kochab, one bright and two faint stars
Grace Ursa Minor's side,
In oblong square; trace her bent tail,
And to the Pole you'll glide."

For the fixedness of the Pole, Kochab its guard, and Dubhe its pointer:—

"The ever watchful Kochab *guards*,
While Dubhe points the pole;
The Pole at rest, sees heaven's bright host
Unwearied round him roll."

On the supposed fixedness of the Pole, from Shakespeare:—

"The wind-shaked surge with high and monstrous main
Seems to cast water on the burning Bear,
And quench the guards of the ever fixed Pole."

Again, Julius Cæsar is made to say, in answer to one who is beseiging him in behalf of a friend,—

"Were I like you I might be moved by prayers;
But I am constant as the Northern Star,
Of whose true fix'd and resting quality
There is no fellow in the firmament.
The skies are painted with unnumber'd sparks;
They are all fire, and every one doth shine,
But there's but one in all doth hold his place."

Shakespeare was guilty of anachronism in making Cæsar speak thus of the "Northern star." In his time the pole of the heavens was not near enough to any star to give it an apparent fixedness. Kochab, and not Polaris, was then called the North Star, as we learn from Arab literature; and we see by turning the earth backward in its "precessional movement," that at that time the pole of the heavens was nearer to Kochab than any other bright star. Twice as long ago it was very near Thuban, a bright star in the Dragon about midway between Kochab and Mizar. We shall refer to this movement more than once in this and the next chapter.

Samuel Butler, in Hudibras, thus refers to the Great Bear and its long tail when ridiculing the beliefs of the astrologers:—

> "Cardan believed great States depend
> Upon the tip o' th' Bear's tail's end;
> That as she whisk'd it towards the sun,
> Strow'd mighty empires up and down;
> Which others say must needs be false,
> Because your *true bears have no tails*."

Virgil, in the Georgics, refers to both Bears and Dragon; we quote Dryden's translation:—

> "Two poles turn round the globe, one seen to rise
> O'er Scythian hills, and one in Libyan skies.
> The first sublime in heaven, the last is whirl'd
> Below the regions of the nether world.
> Around our pole the spiry Dragon glides,
> And like a winding stream the Bears divides;
> The Less and Greater, who by Fate's decree
> Abhor to dive beneath the northern Sea."

"Northern sea," for northern horizon. At the time and place of Virgil's writing, the Great Bear did not dip even her feet in the "northern sea," as at present; but she dips them deeper and deeper every year, and will continue to do so till, in about ten thousand years, in spite of "Fate's decree," she will dive completely "beneath the northern sea." The "Fate's decree," to which the poet alludes, was that of Tethys and Oceanus,—the powers of the ocean,—made in answer to the entreaties of Juno. There were two stories told by the classic authors to account for the origin of the Bear. (It originated long before the earliest Greek history). This one was to the effect that the Great Bear was a maiden by the name of Calisto or Helice—daughter of Lycaon,

King of Arcadia, and an attendant of Diana—the goddess of the chase, the great "Diana of the Ephesians." Jupiter,—the supreme god of that dynasty, and one of the sons of the old god Saturn,—saw this daughter of man that she was fair and took her to wife. (It was customary in those times for all of the sons of the old god Saturn to take to themselves wives of all which they chose of the daughters of men. "There were giants in those days," for the daughters of men bare children to the sons of Saturn, "and the same became mighty men, which were of old, men of renown.* The result was that Juno,—Jupiter's lawful wife,—was jealous of the Arcadian maid," and changed her into the form of a bear. Ovid tells us that Juno said,—"I will take away that beauty with which you have captivated my husband."—

"This said, her hand within her hair she wound,
Swung her to earth, and dragg'd her on the ground;
The prostrate wretch lifts up her hand in prayer;
Her arms grow shaggy, and deform'd with hair,
Her nails are sharpen'd into pointed claws,
Her hands bear half her weight, and turn to paws;
Her lips, that once could tempt a god, begin
To grow distorted in an ugly grin;
And lest the supplicating brute might reach
The ears of Jove, she was deprived of speech.

* * * * * *

How did she fear to lodge in woods alone,
And haunt the fields and meadows, once her own!
How often would the deep-mouth'd dogs pursue,
Whilst from her hounds the frighted hunters flew."

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*Elijah Burritt says,—"Many of the elements and fables of heathen mythology are so blended with the inspired writings, that they must needs be studied more or less, in order to have a more proper understanding of numerous passages both in the Old and New Testament."

"But now her son had fifteen summers told,
Fierce at the chase, and in the forest bold;
When as he beat the woods in quest of prey,
He chanced to rouse his mother where she lay.
She knew her son, and kept him in her sight,
And fondly gazed: the boy was in a fright,
And aim'd a pointed arrow at her breast;
And would have slain his mother in the beast:
But Jove forbade, and snatch'd them through the air
In whirlwinds up to heaven, and fix'd 'em there;
Where the new constellations nightly rise,
And add a luster to the northern skies."

"Juno was in a rage to see her rival so set in honor, and hastened to ancient Tethys and Oceanus, the powers of ocean, and in answer to their inquiries, thus told the cause of her coming. 'Do you ask why I, the queen of the gods, have left the heavenly plains and sought your depths. Learn that I am supplanted in heaven,—my place is given to another. You will hardly believe me; but look when night darkens the world, and you shall see the two of whom I have so much reason to complain exalted to the heavens, in that part where the circle is the smallest, in the neighborhood of the pole. Why should any one hereafter tremble at the thought of offending Juno, when such rewards are the consequence of my displeasure? See what I have been able to effect! I forbade her to wear the human form,—she is placed among the stars! So do my punishments result,—such is the extent of my power! Better that she should have resumed her former shape, as I permitted Io to do. Perhaps he means to marry her, and put me away! But you, my foster-parents, if you feel for me, and see with displeasure this unworthy treatment of me, show it, I beseech you, by forbidding this guilty

couple from coming into your waters.' The powers of ocean assented, and consequently the two constellations of the Great and Little Bear move round and round in heaven, but never sink, as the other stars do, beneath the ocean."*

As the Pole-star has been used for centuries as an emblem of stability, so the Great Bear has been used for at least three thousand years as the emblem of watchfulness. (See quotation given above from Henry Ware, Jr.)

Milton, in his beautiful classic poem "Il Penseroso," says,—

"Or let my lamp at midnight hour
Be seen in some high lonely tower,
Where I may oft outwatch the Bear,
With thrice great Hermes, or unsphere
The spirit of Plato, to unfold
What worlds or what vast regions hold
The immortal mind, that hath forsook
Her mansion in this fleshly nook."

James Russell Lowell makes Prometheus say,—

"One after one the stars have risen and set,
Sparkling upon the hoar frost of my chain;
The Bear that prowled all night about the fold
Of the North Star, hath shrunk into his den,
Scared by the blithesome footsteps of the dawn,
Whose blushing smile floods all the orient."

The use of the Bears, Dipper and Pole-star as guides in determining both time and direction, is frequently alluded to by the poets, especially the ancient. Of course, such passages should not be read till the pupils have discovered that the stars can be so used, but should

*Age of Fable or Beauties of Mythology, by Thos. Bulfinch. A new edition edited by Edward Everett Hale, is published by Lee & Shepard, Boston.

be brought out when that fact is perceived. Explain to them how the Great Dipper has always been used by shepherds and hunters, sailors and soldiers, for determining the time of night. Even during the civil war in our own country, on starlight nights, officers without watches would time the reliefs of guards by the movement of the Dipper. In Henry IV, Act II, Scene 1, Shakespeare refers to the use of the same cluster as a timepiece.—"Heigho! an't be not four by the day, I'll be hanged; Charles' Wain is over the new chimney, and yet our horse not packed."—Tell how the fleeing negro, in slavery times, used the Pole-star as his guide to the land of liberty. Read from Lowell's Biglow Papers how "Birdofredum Sawin" when asked to point out the North star,—that he might lead the negro astray,—"Wheel'd roun' about sou'west, an', lookin' up a bit, picked out a middlin' shiny one an' tole him thet wuz it.". The North, or Pole-star, also called Polaris, has been known by several other names; the one next in frequency of use among English speaking people, being Cynosure, from Cynosura,—the Greek name of the constellation. Milton frequently calls it by that name, also "Star of Arcady," because the little bear was Calisto's boy Arcas, and dwelt in Arcadia before his metamorphosis and translation to heaven. In Comus, the brother, benighted in the woods, says,—

> "Some gentle taper!
> Though a rush candle, from the wicker hole
> Of some clay habitation, visit us
> With thy long levelled rule of streaming light,
> And thou shalt be our star of Arcady,
> Or Tyrian Cynosure."

In L'Allegro, Milton makes a beautiful figurative use of Cynosure:—

"Straight mine eye hath caught new pleasures,
Whilst the landscape round it measures;

* * * * *

Towers and battlements it sees
Bosom'd high in tufted trees,
Where perhaps some beauty lies,
The Cynosure of neighboring eyes."

"Newton, at this passage, quotes from the "Anatomie of Melancholy," the following:—

'Tis the general humor of all lovers; * * * * she is his Pole-star, his guide, his Cynosure, his Hesperus, his Vesperus, etc."

From Milton we will take a long step back to old Homer, and quote,—via Pope,—from his grand "Epic of the Sea of Death,"—according to Keary,*—the passage which refers to the departure of Ulysses from the island of Calypso during his wanderings in search of paradise:—

"And now rejoicing in the prosperous gales,
With beating heart, Ulysses spreads his sails;
Plac'd at the helm he sate, and mark'd the skies,
Nor closed in sleep his ever-watchful eyes.
There view'd the Pleiads, and the Northern team,
And great Orion's more refulgent beam,
To which, around the axle of the sky
The Bear, revolving points his (her) golden eye;
Who shines exalted on th' etherial plain,
Nor bathes his (her) blazing forehead in the main.
Far on the left those radiant fires to keep,
The nymph directed, as he sail'd the deep."

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*Outlines of Primitive Belief, by Charles Francis Keary, of the British Museum. Chas. Scribner's Sons, New York, 1882.

Hence Ulysses sailed eastward from Calypso's island. Notice also the "ever-watchful eyes" of the Bear. Some have argued from this and other passages of Homer that mention the Great, but not the Little Bear, that the Greeks did not at this period possess the latter constellation. Probably they are correct. Josephus tells us that "What is set down by the Greeks is now but of yesterday."

These constellations were, beyond doubt, used as guides to travelers long before Ulysses set out on his voyage of discovery; for man learned how to use them on land before trusting himself to their guidance at sea. That the stars were so used on the deserts is proved by this passage in the Koran: "God has given you the stars, to be guided in the dark, both by land and by sea." Diodorus Siculus tells us that travellers on the sandy plains of Arabia were accustomed to direct their course by the *Bears*. American Indians, when first visited by Europeans, were found to have the same custom, and to call the constellations by the same names.* The honor of first sailing by aid of the stars is usually given to the Phœnicians. Donnelly gives it to the Atlanteans; but when we know what people first intentionally passed beyond the sight of land, we shall know who first used the stars in navigation, for—

"All astronomers agree that the origin of Astronomy is not to be found in history."—*Dupuis.*

"The origin of Astronomy ascends beyond the period of authentic history."—*F. Baily.*

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*Why did not Ignatius Donnelly make use of this fact in his "Atlantis, the Antediluvian World." Harper's, 1884.

"There can be little doubt that Astronomy was nearly coeval with the world."—*Smyth.*

"Astronomy is coeval with the world."—*Argo.*

Certainly no people could have reached a civilization that enabled them to become seafaring, without having perceived that the seven stars of the Dipper were always to be seen in the same quarter of the heavens; especially as those stars revolved in a *much* smaller circle than now, unless that degree of advancement was reached *much* more than six thousand years ago.

Aulus Gellius in "The Attic Nights," gives an interesting discussion on the constellation of the Great Bear in a chapter headed:—"Of the constellation called by the Greeks ἁμαξαν, by us septemtriones. The meaning and origin of each word."—But as we are not at present discussing the origin or history of the celestial bears; or even attempting to give more than a tithe of their connection with literature, we shall not quote the chapter; nor shall we quote from "De Signorum Cœlestium," of C. Julius Hyginus, in which are the legends of over forty of the forty-eight constellations. But from that greatest astronomical and astrological poem of the Latins,—"The Astronomicon, of M. Manilius,—a few quotations are made; not only for the purpose of illustrating our main point, but several other related ones that will appear as we proceed. First, from the translation of Edward Sherburne, made in 1675, of which we believe there are but two copies on our continent:—

"Great Helice moves in a greater bend,
Marked with seven fair stars, the Greek pilots' friend;
Small Cynosura, less both in light and size,

A less orb holds; whom yet the Tyrians prize
More than the Great: by this the Paeni steer
Through *vast* seas to the *western hemisphere.*"

"But,"—says the reader, who knows ancient cosmology only through modern authors,—"that last line cannot be a correct translation of an author who wrote nearly two thousand years ago; for men would not speak of the western hemisphere when they did not know that the earth was a sphere." We regret not having the original of Manilius, with which to test the correctness of Sherburne's translation; for it may be a little forced. But it can be substantiated that the ancients *did* know that the earth was a sphere; either by historic proof, or by the apriori argument, that they could not have studied the stars as they did without coming to that conclusion. Our classic teachers will not agree with us, for they assert that the classics teach a flat earth. But they are respectfully asked to examine a little more carefully the ground on which they stand. To what source do we go *to-day* for our astronomy? Certainly not to novel or theological writers. By such reasoning as many classic teachers employ, we can prove by his writings that Charles Dickens either believed in an immovable heavens and earth, or in modern astronomical miracles that beat that of Joshua's sun "all hollow." By such reasoning we need not go back to Genesis, Joshua, Judges, Job, Psalms, or The Preacher, to prove that—"The sun also ariseth, and the sun goeth down, and hasteth to the place where he arose."—Ec. 1. 5. Nor need we employ the hymn books with such hymns as the following:—

"My God, who makes the sun to know
His proper hour *to rise,*
And to give light to all below,
Doth send him *round the skies.*
When from the chambers of the East,
His morning *race* begins,
He never tires, nor *stops* to rest,
But *round the world* he shines."

It can be proved by any one of our patent medicine almanacs.

The purpose of this little volume does not admit of the discussion of ancient cosmology. But the writer wishes to say, briefly, that the study of the "classics" brought him to the conclusion that the—"circular plate with a hemispherical dish cover"—illustration of Prof. F. A. Paley and others, does *not* give the conception of the universe as held by the educated Greek or Roman; also, that a little more careful study of what the ancients did know and teach would take from us a little of our modern conceit, and make a few corrections in not a few of our elementary scientific, as well as classic text-books.*

One or two of the ancients shall speak for themselves on this and related subjects. First, Manilius, and this time through Thomas Creech, of London,—"done into English verse in 1700." We believe him to be the last

*The same theory of ancient cosmology was reached by Pres. William F. Warren, of Boston University, and published by Ginn, Heath & Co., in 1882. The present writer was not aware of the fact, however, till he asked a publisher, in '83, to publish *his* theory. We are happy to refer those interested in the subject to the President's *multum in parvo*, called "The True Key to Ancient Cosmology." The more happy to do so because those who read it will see that the same conclusion has been reached through two *independent* lines of study;—the astrological, and the more common classic. The President does not seem to have touched the former. His latest work, however, has not come to our notice It may, and we hope does, contain evidence of research in the astrological field.

and best English translator of the great Latin astrologist; and that there are less than half a dozen copies of his translation in America. The extreme rarity of this author, and his logical reasoning are excuse enough for quoting so much from him. Compare his proofs of the sphericity of the earth with the several illogical argu-arguments by which so many modern text-book writers endeavor to prove the same thing. The original is followed in spelling, punctuating and capitalizing, as the extracts will then illustrate the English of the year 1700 Would use the same peculiar type if we had it.

"——Did not Earth hang midst the airy space,
How could the Sun perform his constant race?
Drive on the Day, fall headlong down the West,
Force up the Stars, and rise again at East?
How could the Moon her usual Round maintain,
Rise, set, and rise near the same point again?
Or He that leads the Stars at Night return
To East again, and usher forth the Morn?
But since Earth did not to a Bottom fall,
But hangs, and yielding Air surrounds the Ball,
The way is open, and no stop to force
The Stars return, or to impede their course.
For who can think that when the Sun doth rise
He's born anew, or when He sets He dies?
That when one Day He hath display'd his Light
His Race is finisht, and goes out at Night?
Since He the same doth every Morn appear,
And as He drives a Day He whirls a Year.
From the same East He comes with equal pace,
To the same West He still directs his Race;
And not one Change is seen in Nature's Face.
The same Moon shines, and at a certain Day,
Her light encreases, and Her Horns decay.
The track she made Nature doth still pursue,
Nor like a Novice wanders in a new.

Phœbus still warms those signs where first he shone,
And Day goes round with one eternal Sun.
Thus prov'd: because by just Degrees the Hours
In different Countries are the same with Ours.
The Eastern Nations view the rising Fires
Whilst Night shades us, and lazily retires.
And as to distant West we nimbly run,
That still removes, nor can we reach the Sun.
No East begins, no West his race doth bound,
But he drives on in one continued Round.
  Nor is it wondrous that one single Ball
Should hang, since 'tis the Nature of the All.
No prop supports, but as their motions prove,
The whole World* hangs, and all that whirls above,
The Sun doth drive his Race through yielding Skies,
Wheel round the liquid Bound, and set and rise.
Through Æther, Moon and Stars direct their Race,
Like these, Earth unsupported keeps its place,
Though no fixt Bottom props the weighty Mass.
  Well then, the Earth hangs midst the yielding Air
Not stretched into a Plain, but every where
It rises and declines into a Sphere.
  In other Parts this Figure Nature drew,
The Sun and Stars, if we exactly view,
Seem round, the Moon is vary'd every Night,
Nor with an equal Face receives her Brother's Light.
This proves her round since different rays adorn,
Now shape, now bend, now fill her borrow'd Horn.
  This Form's Eternal and may justly claim
A Godlike Nature, all its parts the same;
Alike and equal to its self 'tis found,
No End's and no Beginning in a Round.

---

*Evidently the author does not mean earth, but heavens. See foot note on page 51. "Seven fires refuse the *World's* Diurnal force, etc." See also Hebrews 1: 2, and xi: 3, where we think a cotemporary author means the same, but is incorrectly translated plural in the King James, and correctly singular in the Douay, the Breeches, and other early English versions. Our *present* belief is that the cosmology of the Scripture writers was, without exception, *phenomenal;* and that correct translations of the three apparent exceptions,—two mentioned above and one in Job xxvi: 7,—will conform to this view. We confess to total ignorance of the *Hebrew* language, and if incorrect hope to be set right.

Nought can molest its Being, nought controul,
And this enobles and confines the Whole.
Hence every Countrey sees not every Sign,
What Sailer views the bright Canopus shine
O'er Egypt's Shores, and when its Rays appear
Who sees the little Circles of the Bear?[1]
For Earth still rising to a Round denies,
A larger Scene, and bounds our feeble Eyes.
  This Truth the Moon confirms when deep in Night
Earth interposes, and diverts her Light,
She doth not all the World at once surprize,
But now seems dark to these, now other Eyes.[2]
The Eastern Parts first view her darkned Face,
Then o'er the South she rolls her broken Rays;
And then still prest by the obscuring shade,
She hears the Western Brass resounding to her Aid[3]
  Now if the Earth were flat the darkned Moon
Would seem to all Eclypst as well as one.
At once presenting to the common view
Her gloomy looks, and prove this fancy true.
But since its Figure's round, deep Cynthia's beams
By just degrees must visit the Extremes;
Not all at once; she must divide the skies,
And while she sets to some, to others rise.
For in the mighty Concave whirl'd above
She rising must, and must declining move;
Now climb this rising, and her Glories show,
Then sink again, and scatter Beams below.
This proves (nor shall the subtlest Wits escape
These twining Reasons) the disputed shape.
  By various Animals this Globe's possest,
The Common House of Man, of Bird, and Beast;
The Northern parts rise high, the Southern fall

---

[1]Canopus is a star in the keel of the ship Argo, said to be next to Sirius in brilliancy. Though this statement of Manilius is incorrect, the argument is not affected thereby.

[2]World here means earth or its inhabitants. This eclipse argument is worth some thought.

[3]Eastern, as well as Western Brass, still resounds to drive away the monster that is swallowing the moon when eclipsed.

Beneath our Feet, the Adverse of the Ball.
Yet as it lies its surface seems a Flat,
Though false, its bigness doth improve the Cheat,
And take the Roundness off, though every where
It riseth and declines into a Sphere.
  Hence when with setting Beams the Sun withdrawn
Beholds our East, they see the Morning dawn;
And when their Toils He with his Light restores,
Sleep sits on Us, and gently easeth Ours.
  The Sea runs round, and with its circling Waves
The Flood at once divides and joins the Halves.[1]
  To this vast Frame in which four parts conspire
Of different form, Air, Water, Earth and Fire,
United God the World's (Note page 49) Almighty Soul
By secret methods rules and guides the Whole;
By unseen passes He himself conveys
Through all the Mass, and every part obeys.
To proper Patients He kind Agents brings
In various Leagues binds disagreeing Things.
Makes some Powers act, and some receive their Force;
And thus whilst Nature keeps her Vital Course,
Though different Powers the sever ıl Things divide,
The World (Note page 49) seems One, and all its parts ally'd.
Now Constellations, Muse, and Signs rehearse
In order, let them sparkle in thy Verse.
Those which obliquely bound the burning Zone,
Aud bear the Summer and the Winter Sun,
Those first: then those which roll a different way
From West: nor Heaven's Diurnal whirl obey:
Which Night's serene disclose, and which create
The steddy Rules, and Fix the Laws of Fate[2]

---

[1]Which halves—eastern and western hemisphere? See page 46:—"the Paeni steer through vast seas to the western hemisphere."

[2]Here the translation does not do the author justice; for "those which roll a different way * * * and fix the Laws of Fate," would seem to be constellations, but they were the *seven wandering stars*,—the GREAT GODS of the astrologers. In chapter XVI Manilius names them and gives the order of their arrangement as believed in his day:—

"Seven fires refuse the Worlds (Note page 49) Diurnal force,
From West to East they roll their proper Course.
Cold Saturn, Jove, fierce Mars, the fiery Sun,

First Aries, glorious in his Golden Wool,
Looks back, and wonders at the mighty Bull,
Whose back-parts first appear: He bending lies
With threatning Head, and calls the Twins to rise,
They clasp for fear, and mutually embrace;
And next the Twins with an unsteady pace
Bright Cancer rolls: Then Leo shakes his Mane:
And following Virgo calms his Rage again:
Then Day and Night are weigh'd in Libra's Scales,
Equal awhile,[1] at last the Night prevails,
And longer grown the heavyer Scale inclines
And draws bright Scorpio from the Winter Signs:
Him Centaur follows with an aiming Eye
His Bow full drawn and ready to let fly:
Next narrow Horns the twisted Caper shows,
And from Aquarius Urn a flood o'erflows.
Near their lov'd Waves cold Pisces take their Seat,
With Aries joyn and make the Round compleat.
Now view the point where turn the shining Bears,
And from their height look down on other Stars.
Which never set but onely change their Sites
To the same point; and whirl the meaner Lights;
Thither the Axis runs, whose adverse Poles[2]
Bears the poiz'd World, and Heaven about it rolls;
No solid substance that the weight might bear
But an imagin'd Line stretcht through the Air;
Begun from either Pole the Line[3] extends

With Mercury 'twixt Venus and the Moon.
Some swift, some slow, they measure different Years,
And make the wondrous Musick of the Spheres."

For a beautiful astronomical reference, including "celestial music," and illustrating a kind of opportunity that we commend be embraced for studying *phenomenal astronomy*, see Merchant of Venice Act V, Scene 1.

[1]When Manilius wrote, the autumnal equinox—equal day and night—was in Libra's Scales; it is now in Virgo.

[2]See quotations from Virgil, page 38.—"The globe turns round two poles, etc."

[3]See Ps. xix: 4, where Pres. Warren says the same line of heavens and earth is probably referred to, and where world means heavens. The first six verses of Ps. xix. are astronomical; the tabernacles are undoubtedly the twelve zodiacal constellations or signs in each of which the sun tabernacles a month.

Earth's Centre through, and in the other ends.
For since the frame turns round, that fancy'd Line
Which cuts the middle, too minutely thin
By turning round itself to measure space,
But still confin'd to one imagin'd place,
Is call'd the Axis; cause unapt to move
It sees Stars whirl, the shining Planets rove,
And swiftly measure the vast space above.
  Fixt near the Pole appear those friendly Stars
Well known to wretched greedy Mariners;
Which guide their Sails, and which direct their Oars,
When mad for gain they fly to foreign Shores.
(Whilst Heaven it self befriends their Avarice,
What Pleas may wretched Mortals make for Vice?)
Seven equal Stars adorn the greater Bear,
Which measure larger Circles of the Sphere,
And teach the Grecian Sailers how to steer.
The smaller Bear, though less in size and light,
In narrower Circles[1] she commands the Night,
Yet Tyre prefers, for through the Ocean tost
They sail by her and find the foreign Coast;
These stand not front to front, but each doth view
The others Tayl, pursu'd as they pursue.
  Betwixt and round these two the Serpent twines,
At once divides, and to their place confines;
Secure from meeting they're distinctly roll'd,
Nor leave their Seats, and pass the dreadfull fold:
These keep the Vertex, but betwixt the Bear
And shining Zodiack, where the Planets Err,
A Thousand[2] Figur'd Constellations roll,
Some near the Zodiack, some plac'd near the Pole:

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[1]Manilius saw both Bears move in much smaller circles than we do, but the Little in "narrower Circles" than the Great, for the pole of heaven was near her head, and she did not possess her present *unearthly* "tayle"! Neither was the handle of the Dipper then reckoned the tail of the Great Bear, as can be proved by philological arguments; hence Prof. Hood (See page 83) did not correctly "imagine" its origin. We own to having made several unsuccessful attempts to trace those "tayles" to their true source. Perhaps some *evolutionist* will come to our aid.

[2]A very decided hyperbole to call less than a score a thousand.

Whose differing Powers by tempering Skies combin'd
Make seasons fruitfull, and refresh Mankind.[1]
First near the North, as conscious of his shame
A Constellation kneels without a Name;[2]

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[1]Manilius was an astrologer and of course a fatalist. His poem begins with a statement of that fact:—

"Stars *conscious* of our Fates and Arts *divine*
The wondrous work of Heaven's first wise design,
In numerous Verse I boldly first inclose;
Too high a subject and too great for Prose.
At what the Ancients with a wild amaze
And ignorant wonder were content to gaze,
My Verse brings down from Heav'n, design'd to show
Celestial secrets to the World below.

* * * * * *

I'll find what Sign and Constellation rule,
And make the difference 'twixt the Wise and Fool;
My Verse shall sing what various Aspect reigns
When Kings are doom'd to Crowns and Slaves to Chains."

[2]In book V, verse 646, Manilius calls him the Humble Constellation. Ptolemy calls him Engonasin,—that is the Kneeling One. Hyginus says that Eratosthenes attached the name of Hercules to him; but neither Ptolemy, Manilius nor Aratus ever name him, but rather speak of him with a sort of superstitious awe. Aratus,—about 300 B. C.,—says of him (via Dr. John Lamb)—

"A *Labouring Man* next rises to our sight:
But what his task—or who this honor'd wight—
No Poet tells. Upon his knee he bends,
And hence his name *Engonasin* descends.
He lifts his suppliant arms, and dares to rest
His right foot on the scaly Dragon's crest."

Dr. Lamb claims that the Greeks received their map of the heavens from the Egyptians, by whom the constellations received their present form; and that the Egyptians produced them by combining two older sets, a Phœnician and a Babylonian. He says:—"Had we now the Babylonian sphere unmutilated, it would be a picture history from Adam to the time of its invention. Commencing at the north: the two chariots (Bears) revolving round the pole, turning each way, one to the east and one to the west, and never setting, with Draco, the great serpent, between them, were the emblems of 'the cherubim and flaming sword turning every way.' The first figure, of which Aratus and the early astronomers give a description from the tradition they had received, is:—'That of a labouring man, a man doomed to labour; * * * *' That this figure represents our first parent, as described in the third chapter of Genesis, no one can doubt.(?) How his name was lost is very evident:—'Adam' in the original language is not only specially the name of our first parent, but signifies generally 'a man.' Hence, in another language it might be rendered 'a man;' and 'Adam doomed to labour,' would become 'a man doomed to labour,' or 'a labouring man.'" (See next page.)

And next Boötes comes, whose order'd Beams
Present a Figure driving of his Teams.
Below his Girdle, near his Knees, He bears
The bright Arcturus, fairest of the Stars.*

This theory of the origin of the ancient constellation figures has been expanded by later writers, among whom we mention Joseph A. Seiss, D. D., author of "A Miracle in Stone" and other works. His "Gospel in the Stars, or Primeval Astronomy" (E. Claxton & Co., Phila., 1882), is a very readable book; based, as the author acknowledges, largely on Miss Frances Rolleston's "Mazzaroth, or The Constellations," (Rivington's, London, Eng., 1875). Rev. James Gall in "Primeval Man Unveiled," and Dr. Samuel Kinns in "Harmony of the Bible with Science" (Cassell, Petter, Galpin & Co., London, Eng., 1881), present the same theory. W. E. Gladstone and George Rawlinson, by reason of their historic theories, are at least in sympathy with this view.

*The Greeks possessed several fables accounting for the origin of this constellation, but our present purpose does not admit of their discussion. We wish, however, to point out an error relative to it which has become very popular through the advocacy of such careless, but well known writers as Dr. Thomas Dick and Elijah Burrett. We quote from page 44 of Burrett's "Geography of the Heavens and Class-book of Astronomy." Speaking of the passage in Job: "Canst thou bind the sweet influences of Pleiades, or loose the bands of Orion; canst thou bring forth Mazzaroth in his season, or canst thou guide Arcturus with his sons?" He says,—" *Arcturus* is the name of the principal star in Boötes, and is here put for the constellation itself. The expression, *his sons*, doubtless refers to Asterion and Chara, the two greyhounds, with which he seems to be pursuing the Great Bear around the North Pole." That "his sons," or daughters, as the Arabs have it,—that is his followers,—*cannot* refer to Asterion and Chara, is evident to every one who knows the origin of the constellation, for it was invented by Hevelius in the seventeenth century. Arcturus himself was beyond doubt Arctos Major, Ursa Major—the Great Bear, and his sons or followers, the present tail stars—Alioth, Mizar and Benetnash or Alkaid. (The Arabic name of η was Al-kayid-al-benat al-na'sh, the governor of the mourners, in allusion to their conception of the four stars of the Dipper representing a bier or its bearers, and the three following the mourners.)

Dr. Lamb on this point quotes from the Hieozoic of Bockart, Vol. II, page 113, "Aish cum filiis suis:" "Aish with her sons." He shows that with some of the Arabian astrologers the name of the greater and lesser Bear was: "Feretrum majus et feretrum minus:" "the greater and the lesser Bier, or Sarcophagus," on which a dead body is carried; and that the three stars in the tail of the Bear were called "the sons of," that is, the attendants or followers of the Bier, which was itself constituted of the other four conspicuous stars in the constellation. Hence Job says: "An feretrum deduces cum filiis suis?"

To point out the numerous instances in which Arcturus, Orion and the Pleiades are mentioned together by ancient writers, where Arcturus certainly means the Great Bear, and where the three constellations are among the most potent in their supposed influence, would require more space than we can give at present, and we leave it for a future work on Astrology —Intended, "D. V.," or "If the stars look with an aspect favorable." (See next page.)

Behind his Back the radiant Crown is view'd,
And shines with Stars of different magnitude;
One plac'd i' th' front above the rest displays
A vigorous light, and darts surprizing rays.
This shone since Theseus first his faith betray'd,
The Monument of the forsaken Maid.
Nor far from these distended Lyra lies,
Well strung, the sounding glory of the Skies.
This Orpheus struck when with his wondrous Song
He charm'd the Woods, and drew the Rocks along;
When Hell obey'd when Death resign'd her Chain,
And loos'd his dear Eurydice again;
This gain'd it Heaven, and still its force appears,
As then the Rocks it now draws on the Stars.
The Planets dance, and to the tunefull sound
The Heaven consents, and moves the fatal Round."

We have quoted one-sixth of the first book of Manilius,—about one-thirtieth of the entire poem, and will simply mention a few other "modern" theories advocated by him.

He tells us that the stars are suns like our sun, of "fiery Nature and Substance," but removed to great distances from earth, and not all to the same distance, as is seen by their difference in brilliancy; and that they

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An amusing incident occurred in a neighboring city during a lecture on astronomy, when a gentleman in the audience asked for the author's view of the above mentioned passage in Job. It was given by repeating Scott's paraphrase:

"When milder stars their gentle influence bring,
Canst thou withhold the beauties of the spring?
Or when Orion lifts his stormy sphere,
Canst thou with flowers adorn the frost bound year?
By monthly stages dost thou teach the sun,
Through the vast circle of his signs to run?
Or guide Arcturus and his sons to roll
In shining ranks about the Arctic pole?"

Our interlocutor replied by saying that he could not accept of that view, as it would compel him to destroy three of his best sermons. His honesty commends itself!

too are hung upon nothing or floating in *aether*, as is the earth and our sun, and not fixed in a solid sphere as some ignorantly imagine. In his discussion of the Milky Way, after ridiculing the various fanciful theories—

> "That Heaven meets here and this white Cloud appears
> The Cement of the close-wedg'd hemispheres," and
> "That old opinion of still more sway
> That the Sun's Horses here once ran astray," and
> "That gentle rumor that must not be supprest,
> How milk once flowing from fair Juno's breast
> Stain'd the celestial pavement, from whence came
> This Milky Path, its cause shown in its Name."

He then presents the true cause in the question—

> "Or is 't a croud of stars crowning the night?
> A candid diadem of condensed light."

One more quotation from Manilius is given; and this as an argument in favor of our early claim that the study of the heavens affords, not only a direct means of the highest value for intellectual training, but an indirect means for moral and religious culture. The passage is one of many which show the religious views of a "heathen" who meditated upon God's law both day and night; and to whom—"The heavens declared the glory of God, and the firmament showed his handy work. Day unto day uttered speech, and night unto night *shewed knowledge*."—

> "A most convincing Reason drawn from Sense,
> That this vast Frame is mov'd by Providence,
> Which like the Soul doth every Whirl advance;
> It must be God, nor was it made by Chance:
> As Epicurus dreamt, He madly thought
> This beauteous Frame of heedless Atoms wrought,
> That Seas and Earth, the Stars and spacious Air
> Which forms New Worlds, or doth the Old repair,

First rose from these, and still supply'd remain,
And All must be, when Chance shall break the Chain,
Dissolv'd to these wild Principles again.
Absurd and Nonsense! Atheist, use thine Eyes,
And having view'd the order of the Skies,
Think, if Thou canst, that Matter blindly hurld,
Without a Guide should frame this wondrous World.
But did Chance make, and Chance still rule the Whole,
Why do the Signs in constant order roll?
Observe set Times to shut and open Day,
Nor meet, and justle, and mistake their Way?
Perform their Course as if by Laws confin'd,
None hasten on, and leave the rest behind.
Why every Day doth the discovering Flame,
Show the same World, and leave it still the same.
E'en then, when Troy was by the Greeks o'erthrown,
The Bear oppos'd to bright Orion shone;
She near the Pole in narrow Rounds did move,
He fac'd her then, and measur'd the vast space above."*

We shall here quote from only two modern authors to whom, as well as to ancient Hebrew, Greek and Roman, the invisible things of God were revealed,—"being understood by the things that are made, even His eternal power and Godhead."—Rom. i: 20.

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*The Bear revolved in much "narrower Rounds" then than now. In fact, during the 2,000 years immediately preceding the time of Manilius, she was her nearest to the pole; or better, the pole was the nearest it ever is to her. It will be over 2,000 years before she will revolve in such "narrow Rounds" again But for 4,000 years Orion has "measur'd the vast space above" at each daily revolution. For during that time the equator has continually crossed his body, and he has risen in the east and set in the west, for every point on the earth except the poles; seen from either of them he has revolved continually in the horizon partly above and partly below. 2,000 B. C. the equator crossed his head and shoulder near his brightest star, α, or Betelgeuza (Ibt-al-jawza, Arabic for—Shoulder of the giant). 1,000 B. C. it crossed him considerably lower on the side of α, but over his other shoulder very near γ, or Bellatrix. Orion has risen more and more into the northern hemisphere; or rather, the equator has kept moving down his body till now it crosses just above his beautiful three starred belt, the upper one of which, δ, or Mintaka (Mintaka-al-jawza, the Belt of the giant) is just below it.

"Who turns his eye on nature's midnight face,
But must enquire what hand behind the scene,
What arm almighty put these wheeling globes in motion
And wound up the vast machine?

* * * * * * *

"'Tis elder Scripture writ by God's own hand,
Scripture authentic, uncorrupt by man."

—*Young's Night Thoughts.*

"Look up and behold the eternal fields of light that lie around the throne of God. Had the stars never appeared in the firmament, to man there would have been no heaven, but he would have laid himself down to his last sleep in a spirit of anguish, as upon a gloomy earth, vaulted over with an impenetrable arch, solid and impervious."—*Jean Paul Richter.*

This chapter already exceeds the limits at first intended, and only a little of the connection of *primary phenomenal astronomy* with science, literature and religion has been shown. The vast amount of literature upon other constellations than the Bears, has hardly been touched, nor have we begun to exhaust that of Calisto and Arcas; but present limitations prevent much further expansion, and we shall close with some quotations from the grandest astronomical poem in existence; of the author of which another poet says,—

"Skillful Aratus sings in easy vein
Th' eternal gems that deck th' ethereal plain—
The wandering Planets—and bright Stars that roll
In their fix'd orbits round the central pole.
Laud his great work—and rank him next to Jove
Who adds fresh luster to the Stars above."

If any writer ever added "fresh lustre to the stars above" it was the fellow countryman of Paul, whose work we feel sure the apostle studied and enjoyed far more than do his successors of the present day. We

believe that Aratus has but *few* readers among either scientific or classic scholars. That he is worthy of *many* the following extracts will prove. Probably the reason he is not read is that astronomers consider the subjects of mythology and astrology beneath their notice; and classic scholars not familiar with *primary phenomenal astronomy*, cannot appreciate either his Phenomena or Diosemeia. He was more highly prized by the Latins, for they made many translations of him, and both Virgil and Manilius frequently borrowed from him. Ovid prophesied that his Phenomena would live forever with the luminaries it describes.

Though the introduction to his Phenomena has been frequently translated into English, we believe that the entire poem,—consisting of 730 lines,—has been "Englished" but three times. As the two best translations are not obtainable through the trade, we shall quote from each, but shall use a translation of the introduction by George Rawlinson,* Camden Professor of Ancient History, Oxford, England. Prof. Rawlinson cannot be accused of favoring a heathen author, hence we desire that Aratus, through him, be compared with later Christian and earlier Hebrew writers. We are also indebted to him for most of the Scripture references accompanying the introduction.

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*Rawlinson's "Religions of the Ancient World" has been published in the Humboldt Library for 30 cents, by J. Fitzgerald, 20 Lafayette Place, New York

"With Zeus[1] begin we[2]—let no mortal voice
Leave Zeus unpraised. Zeus fills the haunts of men,
The streets, the marts—Zeus fills the sea, the shores,
The harbors[3]—everywhere we live[4] in Zeus.
We are his offspring[5] too; friendly to man,
He gives prognostics;[6] sets men to their toil
By need of daily bread: tells when the land
Must be upturned by plowshare or by spade—

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[1] "*The* God, or, as he is called in later times, The Father of the gods and the God of gods. When we ascend to the most distant heights of Greek history, the idea of God, as the Supreme Being, stands before us as a simple fact." Max Müller, "Chips from a German Workshop," Vol. II, page 146. Charles Scribner & Co., New York.

[2] Dr. N. L. Frothingham quotes from the Scholiast Theon at this place:—"Very becomingly does Aratus, being about to declare the position of the stars, invoke in the beginning Jove, the Father and Maker of them. For by Jove is to be understood the Creator of the World." Both Dr. Frothingham and Dr. Lamb use the Latin instead of Greek names, which seems to us proper in this connection, as the constellations are known by the Latin names.

[3] "Said an ancient poet:—'Zeus is the beginning; Zeus is the middle; out of Zeus have all things been made.'" George Rawlinson, "Religions of the Ancient World."

[4] "In him we live and move, and have our being." Acts xvii., 28.

[5] "For we are also his offspring."—*Ibid.*

[6] This poem is but slightly astrological; not much more so than many older, but more common books that we prize highly for the truths they contain.

The Diosemeia, however, is given largely to the discussion of the influence of moon and stars upon the weather—the sun has little to do with it! E. Post, of Oxford, very appropriately translates its title "Weather Forecasts." It would be more "practical" than the Phenomena to those who plant and prune, kill swine and set fence posts according to the age of the moon. And the number of these *lunatics* is much larger than most educated people suppose. We have met many who seemed perfectly sane, and even intelligent on other subjects. The writer once saw a lady stop her daughter, who was about to move some house plants, till she could look in the almanac and see where the moon was. Venturing to ask her reason for doing so, this answer was obtained: "If a plant is moved when the moon is anywhere except in the sign of the Virgin, it may grow well enough, but will not blossom well." She *knew* it was a fact, for she had often *tried* it. But there are all degrees of lunacy, most of us being more or less tinged with astrological beliefs, and a little prefering to see the new moon over the right shoulder than the left. To be sure we do not consult the heavens as much as formerly, or believe that "The stars above us govern our condition," and that "Large foundations may be more safely laid, or houses roofed, if friendly planets aid," nevertheless we plant and reap, buy and sell, eat and sleep, work and worship, more under the control of the stars than ever before. We are slow in shaking off old superstitions and reaching that height of liberty where we can stand beside our poet laureate and say with him:—(See next page.)

What time to plant the olive or the vine—
What time to fling on earth the golden grain.
For He it was who scattered o'er the sky
The shining stars, and fixed them where they are—
Provided constellations* through the year,

"The star or the unconquered will,
He rises in my breast,
Serene and resolute and still,
And calm and self-possessed."

And feel with Beaumont and Fletcher that—

"Man is his own star, and the soul that can
Render an honest and a perfect man
Commands all light, all influence, all *fate*,
Nothing to him falls early or too late.
Our acts our angels are, or good or ill,
Our *fatal* shadows that walk by us still."

Said Cassius to his friend—

"Men at some time are masters of their fates.
The fault, dear Brutus, is not in our stars,
But in ourselves, that we are underlings."

We very easily accept—"the excellent foppery of the world! that when we are sick in fortune, (often the surfeit of our own behaviour), we make guilty of our disasters the sun, the moon and stars; as if we were villains by necessity; fools by heavenly compulsion; knaves, thieves and treachers by spherical predominance; drunkards, liars and adulterers by an enforced obedience of planitary influence; and all that we are evil in by a divine thrusting on: An admirable evasion of a libertine, to lay his goatish disposition on the charge of a star! My father married my mother under the Dragon's tail; and my nativity was under Ursa Major, so that it follows, I am rough and lecherous. Tut, I should have been that I am, had the maidenliest star in the firmament twinkled on my birth." Edmund, son to Gloucester, in King Lear.

"Cæsar believed in his own good luck, and told the pilot in a storm, 'You carry Cæsar and his good fortune.' 'Cromwell had his lucky days, and Nelson had his white days and his black ones.'" But "Wellington, who never lost a battle, never spoke of luck; Napoleon, on the other hand, believed in his star. He was the man of destiny, the picked, the chosen. 'People talk of my crimes,' said he, 'but men of my mark do not commit crimes. What I did was a necessity; I was the child of destiny!' But who can doubt it was for this very reason, that when once the tide of fortune turned against him, a few years of trouble sufficed to kill him, where such a man as Wellington would have melted St. Helena rather than have given up the ghost with a full stomach." Wm. Matthews, LL. D., in "Getting on in the World." S. C. Griggs & Co., Chicago.

*"By his Spirit he hath *garnished* the heavens; his hand hath formed the *crooked serpent*. Job xxvi., 13. (Italics ours.)

"And God said, Let there be lights in the firmament of the heaven, to divide the day from the night; and let them be for *signs*, and for seasons, and for days, and years." Gen i., 14. (See next page.)

To mark the seasons in their changeless course.
Wherefore men worship Him—the First—the Last—[1]
Their Father—[2]Wonderful—[3]their Help and Shield."[4]

Aratus, via George Rawlinson.

"Next hail, harmonious Muses, and inspire
Some portion of your own celestial fire,
Not adverse to a daring Poet's flight,
Who soars on fancy's wings the realms of light.
These diamond orbs their various circles trace,
And run incessantly their daily race.
Round a fixed axis roll the starry skies:
Earth, even balanc'd, in the centre lies.
One pole far south is hid from mortal eye,
One o'er our northern ocean rises high:[5]
Round this *The Bears*, with head to head reverse,
And back to back, pursue their endless course.
With mortals once they dwelt; if truth belong
To old tradition, and the Poet's song,[6]

"Stars, their appearance (in figures) of *animals* He arranged, To fix the year through the observations of their constellations." Assyrian Tablets, translation by George Smith of the British Museum.

[1] "I am Alpha and Omega, the first and the last." Rev. 1., 11.

[2] "Zeus, in the highest conception of the Greeks, was Ζεὺς Πάτερ—Zeus Pater, God Father, from which Max Müller derives Jupiter."

[3] "His name shall be called Wonderful." Is. ix., 6.

[4] "Compare with Ps. xviii., 2; xlvi., 1, and numerous other passages."

[5] See quotations from Virgil, page 38, and Manilius, page 52.

[6] "Aratus prefaces the first fable, which he introduces with εἰ ἔτεον δή; thereby showing that he himself did not credit these fabulous notions, and cautioning the reader to distinguish between the astronomical truths and ornamental fictions of his poem. In like manner Germanicus speaks of the Goat in the constellation of Auriga." Dr. Lamb.

There were two stories quite common with the Greeks to account for the origin of the Bears. We gave first the *tale* which gave origin to the *tail* on which hang Prof. Hood's and Samuel Butler's *tales*. Aratus adopts the other, which makes Helice and Cynosure the two nymphs of Mt. Ida in Crete, who nursed the infant Jove, when his mother Ops secreted him for a year among the Corybantes from the cruel intention of his father Saturn, who received the kingdom of the world from his brother Titan, on condition of not raising male children, but devouring them as soon as they were born. (Saturn—Chronos or Time—devours all things.)(?) When Jupiter was born, "On fragrant Dictos near the Idean mount," Ops deceived Saturn and gave him a stone to swallow in stead. And when Jupiter came into power, in gratitude to his foster-nurses, he gave them each a place in heaven very near to Mt. Olympus,—the North Pole? See Pres. Warren's Work.—"Paradise Found." Houghton, Mifflin & Co.

When saved by craft from Saturn's bloody hand,
Jove's mother bore him to the Cretan strand,
There *Helice* and *Cynosura* fair
Foster'd the babe with all a mother's care.
The Corybantes beat their cymbals near,
Deafening his cries to Saturn's watchful ear.
Grateful his foster-dames, the Poets say,
Jove placed in heaven to run their glorious way.
Pleasing to sight is *Helice's* bright team,
And Grecian sailors hail her guiding beam,
When tossed by adverse winds and tempest black
Mid wintry seas their dubious course they track.
But hardier sons of Tyre, who love to brave
The unknown monsters of th' Atlantic wave,
By *Cynosura's* surer guidance steer,[1]
And safe return to wife and children dear."

Aratus, via Dr. John Lamb.

"The twain disparting, like a river's flood,
Vast wonder, rolls the *Dragon*,[1] bending round
His coil immense; while upon each side stand
The Bears, safe lifted from the dark-blue sea.
One with his tail he measures, stretching far,
While in his folds he clasps the other; its tip
Rests at the head of the bear Helice,
While Cynosura's head lies in that coil,
Which thence descending reaches to her foot,
And thence again twines backward. Nor from one
Point, nor with single star, his huge head shines:
Two in his temples beam, two in his eyes,
While one yet lower studs the monster's jaw.
That head aslant seems nodding towards the tail
Of Helice, with whose extremest end
The jaw and the right temple range in line.
Itself keeps floating near about the spot,
Where furthest West and East embrace each other.[2]

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[1] See quotation from Manilius, page 53.

[2] At each apparent revolution the Dragon's head touched the horizon exactly in the north, "where furthest west and east embrace each other."

Near it there rolls, like to a struggling man,
An *Image*,[1] none knows certainly to name,
Nor what he labors for. But yet they call him
Engonasin; because upon his knees
Crouching he seems; while over both his shoulders
His hands are spread, on this side and on that,
A fathom wide; and full upon the forehead
He tramples with his foot the crooked Dragon.
There too that *Crown*,[2] which Bacchus set on high,
A brilliant sign of the lost Ariadne,
Rolls 'neath the shoulder of the wearied Image.
His shoulder nears the Crown; but for his head,
Seek it by that of *Ophiuchus*.[3] Hence
You may point out that glittering *Serpent-Bearer*
Himself. Below the head the shining shoulders
How manifest! e'en in the full moon's light
They may be seen. The hands indeed match not,
Where only here and there a thin ray glimmers.
Yet still not unobservable, nor mean,
E'en these; but they are burdened with the Snake,
That girdles Ophiuchus. He, firm fixed,
With both his feet tramples that mighty Beast,
The Scorpion, on the eye and breastplate standing
Erect; while in both hands the Serpent writhes,—
Small in the right, but in the left reared high,
And ending with his maw close to the Crown.
Under his coil seek for the mighty *Claws*;[4]

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[1] See note 2 on pages 54 and 55.

[2] See quotation from Manilius, page 56.

[3] "The name of this constellation, translated from that which he bore in the Babylonian sphere into Greek, is 'Οφιοῦχος,' 'Ophiuchus,' 'Serpentarius;' 'qui tenet serpentem,' 'the man who holds or restrains the serpent.' Here, then, follows close upon Adam the promised seed, that is, Seth, who in the early period of the human race was considered to be the promised seed. (See Gen. iv., 25.) In like manner the traces of other antediluvians (Atlanteans? See "Atlantis the Antediluvian World."—Harper's, 1884) may be found north of the equator." Dr. Lamb.

[4] See Manilius, page 52. The twelve constellations of the Zodiac are the same in Aratus and Manilius, except in Aratus there are no Scales. The Scorpion was, and is a long figure, his "Claws" almost reaching the feet of the Virgin. There were then but *eleven* constellations in the Greek Zodiac, but counting

Though these are scant of beams, in nothing splendid.
  Just Behind Helice, moves like a driver
Arctophylax, whom men *Boötes*[1] call,
Because he seems to urge the wain of the Bear;—
In each part shining, but beneath his zone
Outshines the rest, *Arcturus*, radiant star.
  Below Boötes' feet thou seest the *Virgin*,
An ear of corn held sparkling in her hand.
Whether the daughter of Astræus, who
First grouped the stars, they say, in days of old,—
Or whencesoever,—peaceful may she roll!
Another fable[2] runs, that once on earth
She made abode, and deigned to dwell with mortals.
In those old times, never of men or dames
She shunned the converse; but sat with the rest,
Immortal as she was. They called her Justice.
Gathering the elders in the public forum,
Or in the open highway, earnestly
She chanted forth laws for the general weal.

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the claws as though a separate constellation made twelve. Before Manilius wrote, the Scales had been put in place of the Scorpion's claws, some say by Julius Cæsar. Virgil in the Georgics, I, 32–35, says, via Dryden—

"Where in the void of Heaven a space is free,
Betwixt the Scorpion and the Maid for thee.
The Scorpion, ready to receive thy laws,
Yields half his region and contracts his claws."

As represented by all authorities, the Scales occupy the space between the Claws, and they have been reckoned as the seventh constellation of the Zodiac for so long a time that they will probably hold their place; and there is some evidence,—we are not now prepared to say how good,—that they are as old as the other eleven, or a part of them at least. But Julius Cæsar was not able to make the Scorpion contract his claws; they, with the rest of the ancient constellations, are more permanently fixed in the heavens than the stars that compose them—rhetorically speaking. Neither can the modern croakers against these "heathen figures" dethrone them, though the great masses of mankind do not even know of their existence.

[1] See Manilius, page 55. "Arctophylax—Bear Keeper, or Boötes—Herdsman, according as Helice is pictured as a Bear or a Cart. The constellation was known by both names as early as the time of Homer." Dr. Frothingham.

[2] We do not propose discussing at present this "myth of the Ages." The forms in which it appears, both in "sacred and profane" history, are legion; but this is one of the prettiest. "Every myth has a meaning." What does this mean? Atlantis?

Not yet was known contention mischievous,
Nor fierce recrimination, nor uproar.
So lived they. Far off rolled the surly sea.
No ship yet from a distance brought supplies,
But ploughs and oxen brought them. Queen of nations,
Justice herself poured all just gifts on man.
As long as earth still nursed a golden race,
There walked she;—but consorted with the silver
Rarely, and with reserves, nor always ready;
Demanding the old customs back again.
Nor yet that silver race she quite forsook.
At evening twilight, from the echoing mountains
She came alone. No gracious words fell from her;
But when the people filled the heights around,
She threatened and rebuked their wickedness,
Refusing, though besought, to appear again:
'How have your golden fathers left a race
Degenerate! But you shall breed a worse.
And then shall wars, and then shall hateful bloodshed,
Be among men; and grief press hard on crime.'
This said, she sought the mountains; and the people,
Whose eyes still strained upon her, left forever.
And when these also died, those others sprang,
A brazen race, more wicked than the last.
These first the sword, that road-side malefactor,
Forged; these first fed upon the ploughing oxen;
And Justice then, hating that generation,
Flew heavenward, and inhabited that spot
Where now at night may still be seen the Virgin,
Near the far-seeing Driver.——"

Aratus, via Dr. N. L. Frothingham.

Before closing this chapter we wish to acknowledge that there are poets (?) who disclaim having received any inspiration from the heavens; among them is John Oldham, who satirizes the subject as follows:—

"Draw me no constellation there,
Nor dog, nor goat, nor bull nor bear;
Nor any of the monstrous fry
Of animals that stock the sky."

"But the habits of four thousand years are not easily changed. Men will still hold to the fair illusions of old time—illusions that shed brightness over life, and glory over nature, and the starry heavens will continue to be for ages to come, as they have been for ages gone by, a picture-book of Greek fable."

"Gazing on you, ye Stars! with willing ears,
How Memory lists the fables of old Greece
And older Egypt, whose quick loving mind
Found in all Nature something of its kind,
Translated turbulent mortals to your spheres
From out their restless earth, and fix'd them there in peace."[1]

"And may at last my weary age
Find out the peaceful hermitage,
The hairy gown and mossy cell,
Where I may sit and rightly spell
Of every star that heaven doth shew,
And every herb that sips the dew,
Till old experience do attain
To something like prophetic strain.
These pleasures, Melancholy, give,
And I with thee will choose to live."[2]

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[1] From "The Stars," by Patrick Scott. Published in London, Eng., in 1857.

[2] The closing lines of Milton's Il Penseroso. The two finest poems of Milton—L'Allegro and Il Penseroso—are published together, with valuable notes, introduction and short life of the author, by Clark & Maynard, and sent by mail for twelve cents.

IV.

Cosmosphere and Lantern

Experience in schools of various grades has convinced the writer that apparatus should be as simple as possible, and used in a manner that will lead the pupil *to* the study of nature, and not *away* from it. Many mechanical contrivances, found in school-rooms, are useless by reason of their complications; others that are really valuable are abused in the using. An incompetent teacher can no more use a common terrestrial globe successfully than can an unskilled engineer run a locomotive.

The instruments briefly discussed in this chapter are two of several that were at first devised for personal use; but which, when their utility was discovered, the inventor was persuaded to develope and place upon the market, *pro bono publico.*

In connection with descriptions of them he purposes giving a few suggestions of a method in which they may be used; not so much for the benefit of the reader who is already a convert to the general

method of teaching here advocated, as for him who does not fully realize the important truth, that the use of apparatus should always be auxiliary. In this case the strictly proper use of the instruments would be to illustrate only such movements as the learner—from his position and during a limited time of observation—cannot see take place in the heavens itself. A possible use, especially disapproved, would be that of making mere cramming machines of them, with which to produce mental dyspeptics, by serving the pupils more celestial phenomena in a brief hour than could be digested in months. It is not our present purpose to discuss the principles of the new educational method. That has already been done by abler pens.* The object here aimed at is simply to give a few hints for applying the method in a science, where, so far as at present known, it has not yet been attempted.

In a previous chapter a teacher was giving astronomical oral lessons without helps, other than maps of his own manufacture; in this he shall be supplied with Lantern and Cosmosphere. The last named being selected for commencing work, the pupils first view it furnished with its entire black-figured, transparent, blue cover; a remarkable and attractive object, sure to arouse interest and fix attention. Except in being spherical, it

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*A most valuable work on this subject is,—"Lectures on the Science and Art of Education," by Joseph Payne, First Professor of the Science and Art of Education in the College of Preceptors, London, Eng. An edition of over 250 pages, containing the most valuable of Prof. Payne's lectures, has been published by E. L. Kellogg & Co., New York, and is mailed to teachers for 50 cts.

"Quincy Methods," by Lelia E. Patridge, of Col. Parker's Cook County Normal School, published also by Kellogg, is beyond doubt a valuable work on the same subject; though the present writer cannot speak of it from actual knowledge gained by personal acquaintance, as in case of Prof. Payne's work.

bears so little resemblance to anything they ever saw before that it is a perfect riddle.*

Preparatory to first lesson, the instructor removes the southern hemisphere from the frame, when it presents the appearance seen in frontispiece, (with the exception of one line there shown—the ecliptic). Then, with the open half towards the school or class, he inclines the disk—which bisects the globe—to an angle of about 60°, and fastens it. A circular landscape picture is thus presented to view, with the thirty-two points of the compass indicated by letters around the margin. If the pupils have previously learned, even as many as the cardinal points, they now have the key to the entire instrument; and it will interest the teacher to see them unlock it, and to note their questions. "Is the earth flat?" "Which is right, that globe or the old ones that show the earth as round?" etc., etc. He replies to this effect:—"We must find out which is correct; and if the earth is flat, why geographers represent it as a sphere; and if it is a sphere, why this is made flat." He ascertains how much they know about the points of the compass, and, if not familiar with at least eight, teaches them, but does not attempt to "drill" the entire thirty-two into their heads; they will be readily learned from the instrument when needed.

The fastening is then removed which holds the flat-

*Once while setting up our model (a mammoth globe six feet in diameter) in a college hall, a classic student came in with his Greek and Latin books under his arm, and, after surveying the instrument for a few minutes remarked,—"I suppose that was made to teach Zoölogy with, and those pictures show where the animals are indigenous?" The humor seized us to "answer the" classic "fool according to his folly," and we replied,—"Yes; pick out the location of your own state or country by its indigenous animal."

earth plane at an angle with the floor, and it assumes the horizontal position. Moving the semi-meridian till the indicator on the stand-arm points to the correct latitude on the meridian, the axis of the Cosmos. will be parallel with the axis of the earth, and will point to the north and south poles of the heavens; the points of the compass on the horizon of the picture will be correctly located relative to the pupil's horizon. (That is if the instrument stands at the north side of the school-room, where for several reasons every teacher's rostrum should be).

The pupils have—what they need to begin with—an inside view of the northern hemisphere, with the portion of it visible at their latitude, above the plane. There is no necessity of explaining what it represents; merely give them an opportunity to tell what they can about it, or even to *guess* what things mean.* "Those pictures are the pictures the stars make," the pupils will say,—unless they have been *educated* in the old-school *faith method,* in which case they will probably talk like learned fools about "indigenous" things. "Those five-pointed holes in them are the stars." "I see the Dipper. It is in the Big Bear," etc., etc. If the teacher has not the Astral Lantern also, he should be especially careful to have the globe set correctly for about the middle of the next evening, and unless maps have been prepared,—as suggested in the previous chapter,—each pupil should make a pencil drawing of the

*The old-school teacher used to say,—"Must not *guess* about anything, if you don't *know* keep silent." Surely much of his *knowledge* was not as valuable as an intelligent *guess;* for it was not in fact knowledge, but faith, which did not possess even the shadow "of things hoped for"—by the true teacher—to say nothing of the "substance."

Great Bear, with its principal stars correctly located and the seven Dipper stars named. These they will make use of in the evening while tracing the Bear in the heavens.

STAR LANTERN.

If the instructor possess the Lantern, an arrangement is made with the pupils to meet in the evening at some place convenient for observing at least the northern quarter of the heavens. The instrument is easily set for time of day and for latitude. (Difference in longitude does not affect the view of the heavens.) Having placed it upon a stand of convenient height, with the map of the northern quarter of the heavens facing the south, the eastern map appears on the western side, western on eastern, and southern on northern. Thus the students have before them an illuminated celestial globe turned inside out, so that they can see the representation of any portion of the heavens in correct position, instead of reversed,—as on the outside of an ordinary celestial globe; and whichever way they face, they also face the representation of the corresponding quarter of the heavens, and by simply turning a knob, the map is made to move in the direction that represents correctly the movement of the heavens itself; showing the stars rising and setting if looking north or south, rising if looking east, and setting if looking west, passing the artificial horizon in each case, at the correct angle. On northern and southern maps, correct time is read on a twenty-four hour dial, when any star rises or sets, or is in any given position; and

on eastern and western, correct time is easily obtained by a single addition or subtraction.

The Lantern maps are constructed on a different plan from those of the Cosmos.; for on that the sky is transparent, and the constellations opaque, with perforations to represent the stars; while on this, both sky and constellations are as opaque as two coats of printer's ink,—one black and one blue,—can make them. The stars only are seen distinctly from a distance. They are represented by small circular white disks of five sizes, each size differing from the next one, one-hundredth of an inch in diameter (which is as little as the average eye can readily distinguish). Stars having about the same brightness,—termed magnitude by astronomers,—are represented by the same sized disks; and about all seen by the average eye are shown by the five sizes. As some eyes can, on favorable nights, see the brightest of the sixth magnitude, they are shown by very small blue dots.*

A closer inspection reveals, in blue script, the popular and also Greek letter names of all the principal stars; in blue capitals, the astronomical names of the constellations; in unbroken blue lines, the outline of the constellation figures; in dotted blue lines, the area reckoned as belonging to each constellation; also in fine blue stipple work, a very accurate representation of the milky way—as seen on the clearest nights.

*The maps were drawn by Mons. L. Trouvelot, of Cambridge, Mass., formerly of the Paris Observatory, France, and were based on the catalogues of Heis & Gould. The draughtsman employed and the catalogues used were recommended by the astronomers of the Washington Naval Observatory, as being the best for our purpose. They were engraved upon metal plates with great care and expense; and are believed to be,—of star-maps designed for popular use,—not only the most beautiful, but the most accurate in existence.

Still closer inspection shows quite a number of faint blue rings and disks the size of first magnitude stars; also that some of the stars are provided with one, two or three blue rays. These are for beginners in telescopic work, and only such objects are given as are most interesting for examination with small telescopes; some of them being quite beautiful in a good opera-glass. The rings and disks show the location of nebula and clusters. Stars with one ray are variable; with two, double; three, triple, etc.* ε Lyra, which is quadruple in a large glass, has but two rays, as it is only double in an opera or small telescope; ν Draconis is seen to be double with a good opera; in fact an opera-glass is of much more value in the study of the heavens than one who had not made the trial would suppose. With it, not simply a few more, but several times as many stars are seen as with the naked eye; by its aid clusters and nebula are visible that are not discernible without it, and those that can be seen with the unassisted eye, appear much more distinctly; a few double stars are resolved; the mountains of the moon are well defined,—and under favorable circumstances glimpses of the moons of Jupiter may be obtained. Prof. Edward S. Holden,—Director of Washburn Observatory, formerly connected with the Wash. Naval Ob., and author of

*The list of telescopic objects was compiled with considerable care, and may be made of great value to the possessor of a small telescope. The list of star names was obtained by many months of careful work, copying and tabulating for comparison all names used by the leading authors of Europe and America. In that way the typographical errors of both books and maps were detected and avoided, and what is believed to be the most perfect list of star names in existence obtained. On this, as well as other points, criticism is invited; for by reference to manuscript table not only can numerous good authorities be given for every name used, but the errors of those with whom the maps disagree.

several astronomical works, says,—"I consider Mr. Bailey's Astral Lantern the most important single piece of apparatus for a class in Descriptive Astronomy." We would add, and believe that Prof. Holden and other practical teachers will agree with us, that the next most valuable piece, *in comparison with its cost*, is a good opera glass. It is a great mistake to think that *nothing* can be done in telescopic study without an expensive telescope.

With the Lantern, the slow and difficult work of constellation tracing becomes easy and fascinating. The brightest stars are soon learned and the principal constellations traced, as the instrument is far more helpful than any living teacher can be. Pupils will review their evening work by pointing out and naming both constellations and stars on the Cosmos., and will thus accomplish in a few evenings, together with a few reviews on the Cosmos., what would otherwise require a large amount of time.

COSMOSPHERE.

Let us now, for a brief space, consider the progress in astronomical discovery made by beginners while studying both the heavens and the miniature heavens. In doing this it is needful to be more explicit than would be desirable if the book were intended for astronomical readers only. Technical terms shall be avoided as much as possible, and it is hoped that all can follow us, by an occasional glance at the frontispiece.

The Cosmos. is used for some time without any other attachment than its twenty-four hour time dial, and even

that is not employed until the learners discover its use. It lies upon the outside of the instrument, 23½° from the north pole, and is held in position by means of wires radiating from a small ring encircling the axis. It revolves with the globe, but may be moved independently. On the meridian is a fixed hand which always points to the graduated dial, but whether to the correct time depends upon the accuracy with which the dial is set. This attachment is not even mentioned by the instructor. The pupils find it while examining the instrument, and study out its use; or, perhaps, arrive at it in this way: They are reviewing evening work by means of the globe, naming to each other the constellations and stars, yet not agreeing exactly as to their positions. Upon comparing notes, it is ascertained that all were not out star-gazing at the same time; which they conclude accounts for difference in position. The following night more accurate observations are made, and the exact time noted when Pole-star pointers, end of Dipper handle, or any bright star of either Bear, Dragon, Cepheus or Cassiopeia,—is exactly in the north, between horizon and Pole-star. Next day, the globe is turned to the same position and dial corrctly set. Whenever this discovery is made the learners note it in their "Ast. Discovery" memorandum,—giving month and day as well as hour and minute for the determined position. That the same adjustment of dial is good for only one day, or approximately for a very few, is not at first perceived; but must soon be discovered, even by careless observers; when another entry is made, giving, as nearly as can be determined, the difference in position for same time of evening, or difference in time for same position. If it

is half a month later than first obervation, the difference in time for same position is just one hour; and they would be *very* careless observers who would not discover both the variation, and its amount, by even half that time.—Two hours, or one-twelfth of the circle in a month,—the entire circle in a year,—stars revolve once more every year than there are days. Such must necessarily be their conclusions, unless so nearly ruined by a thoughtless method of teaching that they can do nothing but memorize text books. Thus "daily acceleration" and its amount are discovered; likewise that it accounts for our not having the same celestial exhibition throughout the year; but a constant, slowly varying panoramic scene. By detecting related phenomena the student begins the process of reasoning from effect to cause. For he perceives that there is some connection betwéen daily acceleration and the year, and having already seen a relation existing between the sun's position in the heavens and the year, he commences to study the relation of this movement to that of the sun. In order to see what it is, the sun's position and motion must be determined; and as sun and stars cannot be seen at the same time, there is an appeal to the reasoning faculties. If students are so imbued with the method advocated as to work independently, they will reach the desired result by different processes.*

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*A. reasons thus:—Measuring the angle between the eastern point of the horizon and the rising sun shows where, on the horizon of the Cosmos. plane, the sun first appears; and setting the globe for time of sunrise, according to the almanac, his position on that will be exactly opposite the one on the horizon.

B., who is not an early riser, or who cannot see the eastern horizon as well as the western, reaches the same result by a sunset observation.

C. finds the sun's path marked on a terrestrial globe, and from that obtains —for the day of the month—the sun's declination (*latitude* he first calls it, as it

When the sun's place on the Cosmos. is determined, a circular yellow disk used to represent him, is pinned on in correct position, and his apparent motion for that day illustrated. Whenever a later position is determined, and the artificial sun moved to it, his previous location is retained by means of a small circular piece of gummed paper bearing the date.

As the globe cover is metallic, these bits of paper are easily removed at any time, if desired to make corrections. If observation locates the sun in the spring at the time when he rises exactly in the east, it gives the "Greenwich" of the heavens—the point from which to reckon R. A.—right ascension. (R. A. differs from ter-

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corresponds with terrestrial latitude); but the globe not giving him the right ascension (corresponding with terrestrial longitude) he reasons thus:—as the sun is at noon directly above the earth midway between rising and setting, at midnight it must be under the earth midway between setting and rising. Accordingly the instrument is set for midnight, and the sun is placed on the globe under the semi-meridian, at correct distance from the equator. C.'s work has been done entirely in school without making an observation from nature.

D. reasons the same as C., but not having mastered the time dial, sits up till midnight and observes the positions of certain stars, by means of which he sets the Cosmos. and locates the sun.

E. obtains a more accurate result than his classmates by taking into account the amount the sun is fast or slow, as given in the almanac; reasoning that if the sun is fifteen minutes fast, he will be midway between horizons at 11.45.

F.—more independent than either of the others, using neither terrestrial globe nor almanac,—watches the sun set, measures its angle with the western point of the horizon and notes the time; and in the evening observes exactly the position of certain stars and notes the exact time. Next day he revolves the Cosmos. till the observed stars occupy the same relative position, and sets the dial correctly for that position, then turning the globe backward as many hours and minutes as intervened between his two observations, places the sun on the globe opposite the correct point of the horizon.

G., by a little more difficult reasoning, obtains the declination of the sun by midday observation.

We have not exhausted the steps, or combination of steps, by which the novice may obtain the sun's position. A class of enthusiastic pupils, under an enthusiastic teacher, will produce astonishing results on such a problem.

restrial longitude in being reckoned eastward only, and having, for divisions of the circle, hours and minutes.)

By the time observations have located the sun weekly at least for a month or two, it may be advisable to mark the globe with his path for the entire year, giving his position for each day. To do this in a comparatively correct manner is a very easy task for a grammar school boy, but to reach an absolutely correct result will test the ability of a college professor.[1] It might be a good plan to allow the pupils to compete in the manufacture of an ecliptic; the competition to include a written statement explaining how it is to be placed upon the instrument.[2] The work being presented, and decision given as to which is most accurate, the sucessful contest-

[1]Here is an excellent opportunity to illustrate the truth that the learner's work at any given time may embrace all he knows of the subject, and be for him a far better stepping stone to higher attainments, than would be a perfect and complete instrument placed in his hands at the beginning. As he progresses in the study, from time to time he revises his work, and makes it approach nearer and nearer to perfection. Here is also an opportunity to educate the hand to help the head. The teacher who gets a true view of his pupil, sees in him a trinity in unity. And to secure the best results no part of that trinity can be neglected in education. The parts may, figuratively, be called the three H's,—head, hand and heart. It is only in comparatively recent times that any considerable number of the teaching fraternity has been convinced that the best results, even of head education, cannot be reached if that of the hand is neglected. As there are, however, still to be found—in benighted communities—school-houses without a workshop, it is one of the duties of the present generation of teachers to work for their introduction, not for the purpose of teaching trades; but to give the hand that discipline which all hands ought to receive, for the sake of its influence on head and heart, if for no other reason. The Psalmist said:—"If I forget thee, O Jerusalem, let my right hand forget her cunning." But the old school education gave the hand no cunning, and did not see its importance; while the new school educates both hands.

[2]Other attachments that pupils should also construct about the same time, are scales for determining position on the globe. The R. A. scale should be a narrow tape divided into 24 hours, and subdivided into 15° each, but marked as minutes; each space being one degree or four minutes, and should be fastened upon the northern hemisphere at the equator. The Dec. Indicator should be a piece of tape one-quarter as long, spaced into 90°, and provided with a hook with which the zero end is fastened to the equator when used.

ant is allowed to place the attachment upon the globe, where it should remain in use till a better one is offered. The best ecliptics will probably be made of narrow linen tape, in two pieces—one for each hemisphere—spaced and marked for month and day of month. Some pupils will space each half the same, not having discovered that summer is about a week longer than winter. They have noticed that day, as distinguished from night, is the longest in summer, but not that day and night combined is then the shortest. The column in the almanac which gives the amount the sun is fast or slow, begins to mean something to them, and will mean more and more as they proceed. This is believed to be by far the best way to approach the subject. While yet unable to understand the cause, pupils will discover the inequality of the seasons, and will space their ecliptics accordingly, and the spacing will suggest inequality in length of days. By careful endeavors to determine, not only the days in which the sun reaches the equinoctial and solstitial points, but the time of day, it will be discovered that ecliptics, absolutely correct for one year, are not for the next; the sun not reaching the above mentioned points the same time of day on any two successive years, and some years not even on the same day as the preceding.

In the course of study on this point, probably it will be discovered that equal days and nights do not occur when the sun is on the equator, but when he is some distance south of it. Thus arises the subject of the effect of refraction on length of days.

Nothing further will here be attempted in the way of outlining an order of study, which from this point

onward must vary more than heretofore. It is probable that theoretical astronomy has as yet obtained little development in the learner's mind. And it should still be held in check, or, at least, not be allowed to usurp the place of phenomenal study. Apparent movements of sun and stars, first for home latitude, and subsequently as seen at various positions from earth's equator to either pole, should be well understood; for a clear conception of at least that much celestial phenomena is essential as a basis for more advanced scientific study, —especially in geography, astronomy and meteorology; and it is very helpful, not only to the reader of works of travel or exploration—especially in tropical and arctic regions—but to the student of history, mythology and theology.

The latter statement may appear to be a somewhat far-fetched argument; but no very great research will be required to prove that natural phenomena have had much to do with the civilizations of the world and the moulding of the religious developments of its peoples. The student of history must not ignore such an important factor of its cause.

By a glance at the cut of the Cosmos. it may be seen that it is adapted to illustrate perfectly the apparent daily motion of the heavens as seen from any point on the earth. And the reader is requested to follow while an attempt is made to show that the instrument which appears so simple at first view—without any attachment—is capable of remarkable transformations, adapting it to exhibit many movements not heretofore attempted, we believe, by a piece of apparatus. Such illustrations will be selected as can most easily be made clear with a

single cut of the globe, and without special regard to the order or the method of their presentation before a class. With a very slight change in the instrument, easily made in one minute, the revolving motion is transferred from globe to plane; and the actual motion of the observer's plain of earth, which produces the apparent motion of the heavens, is accurately represented.

SUN'S MOVEMENTS.

The cut shows the instrument set for latitude 40° N., and for the time of sunrise about June 21, or sunset Dec. 21. The ecliptic is seen passing obliquely around the globe, half on each hemisphere. The position of the sun for midsummer—June 21—is where the ecliptic crosses the horizon about three-eighths way from the eastern toward the northern points; and his position for midwinter is where ecliptic cuts the horizon about three points south of west. When in his most northern position among the stars, he is near the foot of Castor—the Twin hidden largely by the plane—and after June 21, moves eastward along the path seen to cross the Twins, Crab and Lion, to the left wing of Virgo, where he crosses the equator at the time of autumnal equinox —equal night—on or near Sept. 22. From that time till about March 20 he is moving along the portion of his path lying in the southern hemisphere, hence through constellations not seen in the cut, but shown with the instrument by affixing the other half of its cover. The reader can see, by imagining an object representing the sun moving along the ecliptic from west to east, and the globe revolving from east to west, how accurately

his apparent motion is shown for the entire year. And hence the ease with which the causes of the seasons are shown; viz., varying length of day and night, and varying angle at which the sun's rays strike the earth.

Imagine the semi-meridian to be slid down through the supporting arms, till the axis lies in the plane, and see the movements of sun and stars from earth's equator. Slide the meridian back till the axis stands at an angle of 66½° with the plane—as indicated by the scale—and celestial movements are shown as seen from the northern part of Iceland. On June 21, the sun rises exactly in the north; on Dec. 21, in the south; and during the six months between, at as many points along the eastern horizon between north and south as there are days,—also setting at the same number on the west. Once during every revolution of the globe, the ecliptic is seen to correspond with the horizon.

As it is clearly shown that the sun varies his place of rising and setting least when seen from the earth's equator, the variation increasing with the latitude, till at the arctic or antartic circle the entire horizon is occupied,—so it is shown that as latitude increases within the frigid zone, the sun changes his place of rising and setting more rapidly, appearing and disappearing a less number of times in a year, midsummer day and midwinter night increasing in length, till on reaching the pole the phenomenon of a single day and night is exhibited. There, and there only, the rising sun is seen to move in and parallel with the horizon, making about two complete circuits from the time his upper edge appears before his entire disk is in sight; and working his way upwards slowly, like the threads around a very

fine screw, for three months, when his altitude becomes about 23½°; then sinking for the next three months, and the long day ends, to be succeeded by a twilight of several weeks' duration.

Thus it is seen that the Cosmos. reproduces in a strikingly realistic manner, the phenomena of day and night for every place on earth, and gives, at the same time both the date, and, by means of the dial, time of day for every event.

With its aid the student can easily, and with a tolerable degree of accuracy, construct an almanac for any year or latitude. Greater accuracy is attained if the effect of refraction is considered—which in our medial latitudes causes the sun to appear just above the horizon, when, in fact, he is just below; and which produces twice as great results in the arctic and antartic regions. The causes of the variation of twilight from its least amount at the equator to its greatest at the poles is clearly seen. And the general scientific truth, that light has the advantage over darkness, the world over, is demonstrated. Such an exercise as almanac making would be not only very beneficial, but an excellent test of the learner's proficiency, and hence furnish the best kind of a school examination.

Pupils who have thus studied astronomical geography are better prepared to read history, or even paper and magazine articles upon events happening in different parts of the earth, than those who have tried—in vain—to make geographical gazetteers of themselves. They can understand the correspondent in St. Petersburg, who writes, in the month of June, that he can lie upon his bed at midnight and read by twilight the account of

the American celebration of Fourth of July; or who speaks, in December, of nights nineteen hours long. They can accompany him to Finland, Norway, Sweden, Lapland and Finmark, and understand his allusions to seemingly endless nights, sun not rising for days or weeks, or even in the latter country for months; night being broken only by a short twilight once every twenty-four hours, as the sun approaches, but does not reach the southern horizon.

Perhaps the pupil himself visits Europe, and takes an excursion boat from London or Edinburg across the North sea and up the Norwegian coast to such a point as will enable him to see the "midnight sun,"—after beholding which he darkens the window of his state-room and produces an artificial night in which to take his rest. Or, living upon the western coast of the United States, he may take his summer excursion to Alaska, and within its limits reach a point where the "midnight sun" is seen, not for one or two nights only, but for weeks, or even months.

By this method, the subjects of day and night, and of seasons, become intensely interesting from the first study of them for home latitude, through each step of their variation on the earth, and subsequently their still greater variation upon the other planets of our solar system. The astronomer, at least, can see that an extra ecliptic, differently spaced, and a sun of different size, are all the attachments needed to enable the Cosmos. to illustrate perfectly these subjects for any latitude, of any one of our sister planets, whose inclination of axis and period of rotation are known.

In writing a scientific essay on Celestial Phenomena,

as seen from other planets, the student who has had the merest elements of natural philosophy, will not forget that the laws of Nature are universal, and so will make his observers on different planets vary in stature inversely as the diameter of the planet, placing Liliputians upon the major planets, and Brobdingnagians upon the planetoids.

Though the subject of the division of time by means of day and year upon any planet is sufficiently easy to be within the range of the intellectual capacity of a graduate of a secondary school, the further division into weeks or months will furnish themes broad enough for the university student. For, assuming the progress of intellectual development to be, or to have been the same, on each planet as upon earth—through astrology and polytheism to astronomy and monotheism—the subject of the probable week of each planet would not be the simplest imaginable. Jupiter and Saturn would be well supplied with Moon's days, but probably neither would have a Mercury's day,—*Fr.*, Mercredi,—*It.*, Mercoledi, —*Sp.*, Miercoles,—*Ancient Northmen* Odins dagr,—*Anglo-Saxon*, Vodenes däg,—*Dutch*, Woensdag,—*An. Frisian*, Werns dei,—*Eng.*, Wednesday. Each would probably have a Sun's, a Mars', a Venus', and an Earth's day, but Jupiter would have no Jove's or Thor's day, and Saturn no Saturn's day.

We would not be surprised if some very speculative student of religio-scientific turn found the celestial Paradise on Saturn, as it would be the only planet of our system without a day dedicated to the worship of his S——— majesty.

MOON'S MOVEMENTS.

To illustrate the moon's movements with a considerable degree of accuracy, the ecliptic may be used as her path. As the frontispiece shows the globe in position for the time of sunset in midwinter, the place where the ecliptic cuts the eastern horizon shows where the corresponding full moon rises; and as she occupies the same place in the sphere that her brother does in midsummer, it is seen why the full moon of midwinter runs the highest of any of the year, and is the longest in sight; while the exact opposite is the case with the full moon of midsummer; and in general, why the day—time between rising and setting—of the moon when full, and then only, is as much more than twelve hours as that of the sun is less; and why the moon rises and sets, when full, as much north of east and west as the sun does south, or *vice versa* during the summer months.

When the most prominent features of the moon's motion are understood, or it is discovered that the facts are not *exactly* as stated above, her precise path for any month may be located by any one of several methods; and her movements studied more accurately. It is then seen that, at present, (1885–6) she varies her place of rising and setting during each month only about two-thirds as much as the sun does during each year. In less than five years the variation will be just the same; and in less than ten, her greatest amount of variation will be reached, when full moon of midwinter (for latitudes in the northern part of the United States), will rise in the north-east, and of midsummer in the south-east, the sun continuing essentially the same variation as

at present. By using attachment to Cosmos., by means of which, not only the exact location of the moon's path for any month is shown, but its motion, as well as hers, relative to ecliptic and stars for any length of time, the previously mentioned facts and their cause are clearly seen.

By using the ecliptic as moon's path, the interesting phenomenon of "Harvest Moon" and its cause are shown with approximate truthfulness; but, by using moon's path correctly located, every phenomenon of "Harvest Moon" is shown with perfect accuracy for any year or latitude.

PRECESSION OF THE EQUINOXES.

Reference was several times made in Chapter III.* to the varying position of the north pole of the heavens and consequent difference in position and motion of the Bears at different periods in the earth's history. On page 37 was given an anachronism of Shakespeare, due to his not understanding the precessional movement. Many similar blunders might be given, not from popular writers only, but also from scientific. A geologist refers the glacial epoch to this movement. A pyramidologist makes the false statement that 2170 B. C., when the north pole star—Thuban—was at its lower culmination—lowest point of its daily orbit—and shone directly down the north passage of the great pyramid, Alcyone was exactly in the zenith. (It lacked about 25°.) A very fine writer, in his—in many respects—admirable work, "Ecce Cælum," says on page 79: "Let

*Pages 37, 38, and notes on pages 53 and 58.

the men of the year 13860 look in the north-west for their north." The present writer does not feel like censuring a theologian for such a mistake, as he has met several teachers of astronomy holding the same erroneous conception; obtained, undoubtedly, not through a misunderstanding of the theory, but because they had failed to connect theory with phenomena.

As the effects of this motion are so seldom well understood, yet so clearly shown by the Cosmos., your attention is invited to a very brief discussion of some of them that can be made clear with the picture of the instrument; from which it is hoped the reader will perceive that with the apparatus he would be able to place himself anywhere on earth, at any date past or future, and see the correct position and motion of every object in the heavens.

The star seen in the picture nearest the nose of the Little Bear is *α* Draconis—Thuban—the north pole star of 4,000 and 5,000 years ago. Half as long ago the pole was midway between that star and its present position near Polaris. Its movement is in a nearly perfect circle, about 47° in diameter, having its center at the third coil of the Dragon. The circle is not shown on the picture, but is of the same size as the one there seen to encircle the pole, and lies half its diameter to the left, having the circumference of that circle in its center. In 2,000 years the pole will be near *γ* Cephei—Errai—"The Arab shepherd's boast," in the left knee of the monarch, Cepheus, the lower part of whose figure is shown above the pole. In 4,000 years *β* Cephei—Alphirk, on the monarch's waist, will serve the same purpose; and in 6,000 years *α* Cephei—Alderamin, just

above the left arm of the same figure. In 12,000 years, *a* Lyrae—Vega, one of the brightest stars of the northern hemisphere, which now rises near the north-east, passes overhead exactly in or near the zenith—according to latitude of observer—and sets near the north-west, will serve as pole star, though it will never be quite as near the pole as is Polaris. Then will Polaris present about the same phenomena that Vega now does. Then will the Great Bear "bathe" not only her "blazing forehead," but her whole body "in the main." (See extract from Homer, page 43.)

The Lyre is seen near the left leg of Hercules—the god-begotten man according to Greek mythology—whose foot rests upon the head of the Dragon.—"And the Dragon shalt thou trample under feet." Ps. xci., 13. Some centuries after leaving the Lyre, the pole will cross the leg of Hercules, and centuries later the right knee, during which time his head will nearly reach the northern horizon and the zenith alternately every twelve hours. Slowly the pole will move on till, in about 20,000 years,—

> "When round the great Saturnian year has turned,
> In their old ranks the wandering stars shall stand,
> As when first marshalled by the Almighty's hand."

Though no one now accepts the chronological theory on which these lines are based, it is true that the stars will then appear to revolve as they did 6,000 years ago; the center of their daily motion, having itself completed one revolution around its center,—"The trunk of every cosmical tree," around which the serpent has been coiled for many thousands of years. (This interpretation is not given as the result of research, nor, if it prove the

true one, will the writer claim inspiration as the source of the thought, though it is believed to be a new one.)

In Chapter III. we mentioned the fact of retiring from the field of ancient cosmology on learning that the work of an abler pen had reached the public with the same theory which we had partially developed by an entirely different line of study. Since making the above quotation from Pres. Warren's work, from memory, we have re-read the pamphlet, and to present the President's conclusion, and at the same time show the relation of such study to *primary phenomenal astronomy*, make the following quotation:—

"There are very strong reasons for believing that the Gardens of the Hesperides were nothing other than the starry gardens of the circumpolar sky; that, therefore, the Hesperides were called the 'Daughters of Night,' and that the great serpent which assisted the nymphs in watching 'the golden apples' was none other than the constellation Draco, whose brilliant constituent *a*, the astronomer's Thuban, was, less than fifty centuries ago, the pole-star of our heaven." * * *

"As to the supposed difficulty of imagining a heaven-upholder so tall that it would take a brazen anvil nine days and nights to fall from his head to his feet, if Professor Paley had remembered Sandalfon, the Talmudic Atlas, he would hardly have thought it necessary to locate the Hesiodic one on the edge of the earth where the sky is low. Of Sandalfon, Rabbi Eliezer has said, 'There is an angel who standeth on earth, and reacheth with his head to the door of heaven. It is taught in the Mishna that he is called Sandalfon; he exceedeth his companions as much in height as one can walk in five

hundred years, and that he standeth behind the chariot (Charles's Wain) and twisteth or bindeth the garlands for his Creator.'"

"Atlas's pillar, then, is the axis of the world. (Universe. See pages 49 and 51.) It is the same pillar apostrophized in the Egyptian document known as the great Harris Magic Papyrus, in these unmistakable words: 'O long column, which commences in the upper and in the lower heavens!' It is, with scarce a doubt, what the same ancient people in their Book of the Dead so happily styled 'the spine of the earth.' * * It is the umbrella-staff of Burmese cosmology, the churning-stick of India's gods and demons. It is the trunk of every cosmical tree. It is the Tai Kih of the Chinese universe; the tortoise-piercing (earth-piercing) arrow of the Mongolian heaven-god; the spear of Izanagi. It is the cord which the ancient Vedic bard saw stretched from one extremity of the universe to the other. Is it not the Psalmist's 'line' of the heavens which 'is gone out through' the very 'earth' and on 'to the end of the world'? It is the Irminsul of the Germans, as expressly recognized by Grimm. It is the tower of Kronos. It is the Talmudic pillar which connects the Paradise celestial and the Paradise terrestrial."

"The fuller illustration and vindication of this key to ancient cosmology, its application to different systems of mythology and mythical geography, and the systematic exposition of said systems in accordance with this new interpretation, are tasks reserved for future and fuller treatises. The studies already completed render it certain that every existing systematic exposition of classic mythology is to be supplanted. Equally

interesting is the question of the adaptation of this reconstruction of ancient cosmology to throw light on early Hebrew conceptions of the world and of Sheol."

What the Pres. has done in his "future and fuller treatise"—Paradise Found—we do not yet know, but anticipate much pleasure and profit from the work, in which it is conjectured he has found Paradise in the northern heavens, and Sheol in the southern. In this connection we recall hearing Gerald Massey, of England, make the following statements—as nearly as memory can reproduce them:—"Beyond doubt the entire myth of the Garden of Eden is astronomical in meaning." "We have sufficient evidence that the 26,000 year precessional motion of the earth has been completed at least twice during the history of man." If Mr. Massey has ever written upon this subject we are not aware of the fact.

Let us resume our leading topic lest by wandering too far or presenting too much that is speculative, we shall be accused of "wearing the cloth." It is hoped, however, that speculations have been presented as such, and not as established facts.

The movement of the north pole among the stars during one "Saturnian year" having been indicated, let us now see if the precessional movement changes the direction of the points of the compass, and will require the "men of the year 13,860 to look in the north-west for their north."

Suppose you are able to build a house of such material that it will stand "for ever and ever." On the east side you place a straight-edge at an angle with the horizontal base equal to your latitude, the angle opening

northward. (You are supposed to be anywhere north of the equator). By observing the heavens along the straight-edge, you will perceive that the pole star revolves daily in a circle only about 3° in diameter. After departure from your present body, you visit your old home in an invisible spiritual body. Of course you will always come when "night's sable mantel shrouds earth in darkness," for disembodied and even materialized spirits always prefer darkness to light, not because their deeds are evil, but it is their object to impart light to men sitting in darkness. You, however, will return for the purpose of gaining information, and will occupy your old observatory at the south-east corner of the house, from which position you will see Polaris revolving in diminishing circles for several generations, when his orbit will begin to enlarge, and in about 1,000 years will be as large as that of Errai. His will continue to increase, and that of Errai to diminish till in about 2,000 years that will begin to increase also. Thus you will continue observations for nearly 26,000 years before the cycle is completed, and you have seen the various north pole-stars of earth succeed each other in occupying the position nearest your line of sight. You will always look towards the same point of the horizon for north, and will always (unless frightened away by approaching dawn) see the sun rise in the same direction at corresponding times in the year, and run the same daily course, though his position among the stars will differ for corresponding seasons. This will convince you of the mistake made by certain 19th century geologists who ascribed the glacial period to this movement's change of seasons; for you will see that all the change it makes is

to vary a little the relative lengths of summer and winter, a cause not sufficient to produce the epoch with which it has been connected.

As the discussion of the changing position of the sun among the stars, produced by this motion of the earth, is more interesting than that of the north pole, more intimately connected with ancient literature, and more fundamental to the study of the early history of our race, we regret that it cannot be so easily presented with only the picture of the globe. Hence we have concluded to simply make the assertion, (and in a foot note* prove its truthfulness to our astronomical readers) that, with the Cosmos. properly adjusted, the changing position of every celestial body—produced by the precessional motion of the earth—is as clearly and correctly shown, as seen from any point of observation, as the change produced

*Just inside the wire frame are two slotted arms reaching in opposite directions, 23½° from each pole. The axis is movable along these arms. For illustrating the movement of moon's path and nodes, it is set 5°, and for precessional motion, 23½° from its present position. The center of rotation then becomes the axis of the ecliptic, the equator becomes ecliptic, and the twenty-four hour circles of Dec., circles of longitude. Time dial and cover are removed from the frame, and a hemispherical cover with constellations correctly located upon it substituted. In making the change north pole was depressed, and south pole elevated 23½°; hence the semi-meridian must be slid upwards that amount, to bring the axis parallel with that of the earth. Thus set, the rotation of the globe illustrates the apparent change of northern hemisphere as seen from observer's latitude, produced by the precessional motion of the earth. To illustrate the actual motion of celestial axis, and of observer's plain and horizon, it is only necessary to remove the plumb-rods that level the plane, and, by a set screw, make the plane permanent relative to the axis. Setting a thumb-screw at the upper end of semi-meridian, fastens the globe; loosening another allows the axis, with its fixed plane, to revolve; and, to an observer at the center of the plane (who does not realize its motion,) the phenomena is the same as before. When plane is set at right angle with its axis, its edge shows location of celestial equator at the time the pole occupies any given position; and its movement that of equator along the ecliptic, angles between them remaining constant. Nutations are shown by varying speed of motion, and amount axis is inclined to ecliptic, both of which must be exaggerated to be perceived.

by the rotation of the earth upon its axis is shown for latitude 40° north with the instrument set as seen in frontispiece. Also, just as easily as change is made from phenomenal to actual in case of "daily" motion, so is it with the "precessional."

It is evident, to the astronomer at least, that but few of the many illustrations of which the Cosmosphere is capable have been selected; simply those that could be most easily presented to the largest number. It is also evident that the apparatus can be used to great advantage in a school of any grade from primary, or at least intermediate, to university; and by teachers employing either old or new methods.

Well aware that neither instruments nor method set forth will survive the test unless fittest to survive, they are presented to the best critic—the practical teacher. If they meet his approval, and stand the test of actual service, the author will feel abundantly paid for his labor in the assurance that a little something has been done to assist others to "look up, not down; out, not in; and lend a helping hand."

Testimonials.

For information respecting school, institute, assembly or public lectures, read the following commendations selected from hundreds received during two years work in the field. For further particulars, address the author at Northville, Mich.

ILLINOIS.

From Superintendent Public Schools of Chicago.

CHICAGO, Oct. 5, 1884.

MR. BAILEY:—Your explanation of your Celestial Globe before the Principals' Association was received with great satisfaction. It seems admirably designed to clear up many of the questions in astronomical geography, as well as in astronomy, which often trouble the learner.

Truly yours, GEO. HOWLAND.

From Chicago Evening Journal, Oct. 4, 1884.

The special topic at the meeting of the principals of the city schools this morning was mathematical and phenomenal geography. The speaker was Prof. Bailey, who illustrated the subject with a transparent globe of his own make and invention, which puts before the eye the phenomena of the precessional and all other movements of the heavens, and is adjustable for any minute of the year. The globe, the speaker claims, is the largest in the world, and is an ingenious piece of mechanism, presenting scientific facts in an entertaining manner to the popular auditor or pupil. The talk elicited close attention and a vote of thanks for the "masterly and lucid presentation of the subject."

From Prof. O. S. Westcott, Prin. North Div. High School, Chicago.

CHICAGO, Oct. 10, 1884.

PROF. F. H. BAILEY—*Dear Sir*:—Permit me, in this manner, to express my hearty thanks for your kindness in giving the teachers and pupils of the North Division High School an opportunity to inspect your ingeniously contrived Celestial Globe.

I hear from them only unqualified praise for the invention and the inventor. One cannot help commending the manner in which, by its use, we have had so thoroughly explained many phenomena which before were both abstruse and vexatious. I sincerely hope that you will soon be able to put your invention on the market, that all may have an opportunity of availing themselves of your skill. I heartily wish you every success.

Respectfully, O. S. WESTCOTT.

From Supt. Chicago Athenæum, 48 to 54 Dearborn Street.

CHICAGO, Oct. 24, 1884.

PROF. F. H. BAILEY—*My Dear Sir*:—The evening spent at the Athenæum in listening to your informal lecture on The Heavens, illustrated by your Celestial Globe and Astral Lantern, will long be remembered by those who were present, as one of rare interest and intellectual profit.

No astronomical globes or charts that I have ever seen could give so clear and accurate information in regard to the relation of our earth to sun and stars, or serve as such a help to youth in the study of geography as the Globe which your knowledge and skill have produced.

The adoption of your Globe and Lantern in every high school and college would intensify the interest in the already fascinating study of Astronomy, and make clear to the eye the varied phenomena of the heavens from the equator to the pole.

With best wishes for your welfare,

Yours very truly, E. I. GALVIN.

Cook County Normal School, Francis W. Parker, Principal.

NORMAL PARK, ILL., Sept. 22, 1884.

PROF. F. H. BAILEY—*My Dear Sir*:—I thank you heartily for the excellent lecture you gave to my pupils, upon a method of teaching astronomy and mathematical geography. I have had some experience in trying to teach mathematical geography, and have seen it taught by a method that seemed to me to be right. I am thoroughly convinced that we must begin with the apparent motions of the heavenly bodies, and phenomena that can be apprehended by the senses. Your Celestial Globe is the best piece of apparatus of the kind that I have ever seen. It is simple, and sufficient for its purpose. I should not wish for anything better for an aid in teaching the subjects above mentioned. I cordially recommend you to all my fellow teachers, and beg leave to assure them that they will gain much by seeing your Globe, and by listening to your lectures. Very truly yours, FRANCIS W. PARKER.

From Northwestern University, Evanston, Ills.

Prof. F. H. Bailey exhibited his Celestial Globe to our students, and illustrated its important uses, much to the evident enjoyment of all present. It appears to be designed with much ingenuity and to be of great service in the hands of an enthusiast like the inventor, as an aid to the imagination in placing before the mind a clear conception of the real movements of the heavenly bodies; and it is especially helpful in presenting to the eye the connection between these real movements and the observed phenomena of the Celestial Sphere. H. S. CARHART, Prof. Physics.

Oct. 27, 1884.

AURORA, Ill., Feb. 20, 1885.

PROF. BAILEY:—I wish to thank you for the instruction and entertainment we have had from your lectures.

You know *what* to teach, and your method of teaching is most approved.

Cordially, W. B. POWELL, Supt. Schools.

Ottawa High School.

OTTAWA, Ill., Feb. 24, 1885.

I take pleasure in stating that Prof. F. H. Bailey has delivered three of his lectures on astronomy in our High School Hall, and that I most heartily recommend them.

His lectures are live, interesting and very instructive. Our pupils of every grade are delighted with them. I wish they might be delivered in every city in the land

I hesitated about putting them on here, as I feared it would not pay; yet, in spite of several other attractions in the city at the same time, the success has been most remarkable.

Very truly, CHARLES W. TUFTS, Principal.

INDIANA.

VALPARAISO, Ind., March 14th, 1885.

The lectures delivered here by Prof. F. H. Bailey, and illustrated by the use of the Cosmosphere, gave good satisfaction. As a means of instruction in mathematical geography and astronomy his lectures are invaluable.

Respectfully,

W. H. BANTA, Supt. Valparaiso Schools.

Office of the Principal of the Northern Indiana Normal School.

TO WHOM IT MAY CONCERN: VALPARAISO, Ind., March 14th, 1885.

I have had the pleasure of hearing Prof. Bailey, as well as examining the apparatus which he has invented. The lecture was one of the most instructive that I have ever heard. Any lecture association or school of any grade can employ the Prof. with the certain security that the lectures will more than give satisfaction. Too much praise cannot be given in behalf of his invention. It is superior in every particular and will certainly find its way into every school.

H. B. BROWN, Principal.

LAPORTE, Ind., March 15th, 1885.

PROF. F. H. BAILEY—*Dear Sir*:—Your talks with our children on the astronomical facts, illustrated by your ingenious apparatus, have done much to stimulate interest in the matters concerned. I learn from the teachers that the children in the primary grades have returned with renewed zest to their observations of the sun, moon, stars and weather, and that they are full of questions and suggestions on these things. In the grammer grades, too, astronomy is uppermost just now, and crops out in all the lessons. I hope you may be successful in your endeavors to place your apparatus in the market at an early date. I am sure it will prove a great help in the hands of thoughtful teachers and eager children.

Respectfully W. N. HAILMANN, Supt. LaPorte Pub. Schools.

From Notre Dame University.

NOTRE DAME, March 25th, 1885.

Prof. Bailey lectured before our students on the 24th inst., and gave the greatest satisfaction to all. His lecture on "Astronomy" was beautifully illustrated by the "Cosmosphere," an invention of his own, and his exposition of the various phenomena of which he treated was so lucid as to be followed with ease by every one in his audience. We heartily commend Prof. Bailey and his work to the attention of educators and to those in any way interested in the science of astronomy.

T. E. WALSH, C. S. C. President.
J. A. ZAHM, C. S. C., Prof. Ph. Science.

St. Mary's Academy.

NOTRE DAME, Ind., March 23d, 1885.

The lectures on "Astronomy" by F. H. Bailey are eminently suited to their purpose, viz., to enkindle the enthusiasm of the young astronomer. The globe which he soon intends to put in market, will prove a valuable auxiliary to the teacher in illustrating to the pupil the diffirent motions of the heavenly bodies, the precession of the equinoxes, and the consequent change of the Pole-star. We believe no globe previously constructed has been able to show this last named motion. SISTERS OF THE HOLY CROSS.

MICHIGAN.

Adrian High School, A. E. Curtis, Principal.

ADRIAN, Mich., May 12th, 1885.

PROF. F. H. BAILEY—*Dear Sir*:—I take great pleasure in acknowledging to you the pleasure and profit I have derived from your two lectures recently delivered in this city.

Your celestial globe seems to be admirably adapted for making plain many of the phenomena which confuse and discourage the student of astronomy. I was particularly pleased with the manner in which the moon's movements were ilustrated. No one, even the most indifferent or dull, could fail to be instructed by your explanations.

Very truly, A. E. CURTIS.

Ann Arbor Public Schools, Walter S. Perry, Superintendent.

ANN ARBOR, Mich., May 18th, 1885.

MR. F. H. BAILEY—*Dear Sir*:—It is due to you to acknowledge the excellence of the lectures given by you in our High School Hall last Friday and Saturday. The lectures were exceedingly valuable and interesting to teachers, pupils, and others, who were fortunate enough to hear them.

The success of your apparatus in clearing up the haze that, to most persons, hangs about astronomical facts, and the movement of the heavenly bodies, is something wonderful. I heartily commend your work to the schools of the State.

Respectfully, W. S. PERRY, Supt.

We indorse the above statements.

H. S. CHUTE.
L. D. WINES.

Ypsilanti Public Schools, R. W. Putnam, Supt.

YPSILANTI, Mich., May 25th, 1885.

In the early days Astronomy was the "Queen of the Sciences." With a globe and a telescope a school could be finely equipped for astronomical work. The other sciences were hampered by poor methods and a costly apparatus. Of late years improvements in methods of teaching and in illustration have given rivals the advantage, and astronomy has been thrust into the background and almost ignored. Recent improvements by Prof. F. H. Bailey have given the subject a new claim upon the schools. His Astral Lantern was the first practical improvement in astronomical apparatus in fifty years; and it is not too much to say that more star work can be done with that instrument in three evenings than with the celestial globe or planisphere in six weeks' time. By his more recent invention, the Comosphere, the Professor has rescued his topic from the place it has recently occupied as an abstraction, and placed it among the illustrated sciences. The motions of the heavenly bodies, both diurnal and periodic, are beautifully illustrated, and are so clearly shown by this instrument that it is safe to predict a revolution in teaching astronomy as soon as the Comosphere is placed upon the market. R. W. PUTNAM.

It gives me much pleasure to endorse Supt. Putnam's statement.

JAS. H. SHEPARD, Inst. Nat. Science, Ypsilanti, Mich.

State Normal School.

YPSILANTI, Mich., May 29th, 1885.

PROF. F. H. BAILEY—*My Dear Sir*:—Permit me to express my great satisfaction with the lectures you recently gave here on the subject of astronomy, and especially at the working of your "Comosphere." It is a piece of apparatus that *shows* the various movements of the celestial sphere better than anything I have before seen; and when you put it upon the market, as I hope you will soon do, I shall try to possess myself of one for use before my own classes.

Yours very truly, LEWIS McLOUTH.

From the Pastor Fort St. M. E. Church.

DETROIT, Mich., Aug. 27, 1884.

I have listened to no more enjoyable lectures on astronomy than those given in our church by Prof. F. H. Bailey. His course, brief as it was, was marked by increasing popularity and interest. The simple and lucid exposition of his theme, the arrangement and handling of his Globe, the familiarity with the literature of his subject, the graphic and picturesque quality of his statements and descriptions, give him a rare facility in making plain, even to minds least scientific, the outlines and principles of his most fascinating study. His talk to children was a marvel of simplicity and suggestiveness, and was received with marked eagerness and delight. He carries with him our heartiest congratulations and wishes for a successful career.

CHAS. M. STEWART.

From A. H. Gillet, D. D., Supt. of Four S. S. Assemblies.

DEAR MR. BAILEY:—It affords me great pleasure to bear testimony to the value of your illustrated lectures on astronomy given at Island Park and Monona Lake Assemblies. Your Lantern and Globe are most ingenious and valuable inventions, and, in your hands, afford most striking and luminous illustration of many celestial phenomena hitherto understood by the few only.

I congratulate you on your success, and predict for you still larger success in the future. I shall follow your work with interest, and shall hope for your co-operation in Assembly work whenever possible.

Sincerely yours, A. H. GILLET.

From Prof. E L. Wilson, Ph. D,

MONONA LAKE ASSEMBLY, Wis., Aug. 7, 1884.

PROF. F. H. BAILEY—*My Dear Sir*:—Before I leave I want to tell you how much enjoyment and instruction I have received from your lectures with your wonderful Globe, and how I have been made to marvel over the revelations made by your ingenious Astral Lantern. It must be a great help to teachers in astronomy.

You are certainly entitled to great gratitude and patronage, and are as much the master of your subject as you are of your wondrous inventions.

Very truly yours, EDWARD L. WILSON.

Selections from "What Astronomers Say" of the Astral Lantern.

From the U. S. Naval Observatory, Washington, D. C.

March 10th, 1880.

It gives us great pleasure to recommend Mr. F. H. Bailey's Astral Lantern, as ingenious and very correct as far as can be seen from a casual inspection.

We take great pleasure in recommending this apparatus to schools and colleges, as a very useful adjunct to lessons in astronomy.

JOHN RODGERS, Rear Admiral, Supt.

THEO. F. KANE, Com. U. S. N. J. R. EASTMAN, Prof. Math., U. S. N.
ASAPH HALL, Prof. Math., U. S. N. E. S. HOLDEN, " " "
WM. HARKNESS, " " " EDGAR FRISBY, " " "

From the Director of the Observatory of Georgetown College, D. C.

March, 1880.

DEAR MR. BAILEY:—The explanation and exhibition of your Astral Lantern last night was quite a pleasure to us. It is the most convenient and satisfactory apparatus I have ever met with during many years of experience, for becoming acquainted with the constellations of the heavens, and the members of each.

I think it will not only become very popular among astronomical students, but also among private families for instruction and amusement. I wish you every success. Respectfully yours, JAMES CURLEY, S. J.

From S. C. Chandler, Harvard College Observatory, Cambridge, Mass.

April, 1880.

I have examined Prof. Bailey's Astral Lantern very carefully, and with great interest. Its adaptation to the educational purpose for which it is designed seems to me admirable, and is so well contrived as apparently to require or allow very little room for suggestion of improvement. The general aspect of the heavens, the various configurations, the comparative brightness of the stars, and the relations to the observer and his horizon are most intelligently and faithfully illustrated. I consider the device much superior to anything in use for the purpose of uranographical instruction. S. C. CHANDLER, JR.

From C. S. Lyman, Sheffield Professor of Astronomy and Physics, Yale College, New Haven, Conn.

April, 1880.

Mr. F. H. Bailey's Star-maps Lantern supplies very satisfactorily a long-felt want of students in practical Uranography. For use at night in identifying stars, tracing the constellations, etc., it is the best piece of apparatus yet devised, and should find a place in every school and college.

C. S. LYMAN.

From Astronomical Observatory, University of Michigan.

ANN ARBOR, Oct. 11, 1882.

Mr. Bailey has shown his Astral Lantern to us, and we find it worthy of decided commendation. It is simple and attractive, and the maps seem to be made with a great deal of care. It seems to us well adapted to the wants of the teacher of Astronomy and the amateur possesser of a small telescope.

M. W. HARRINGTON, Director.
J. M. SCHAEBERLE, Assistant.

From Prof. C. S. Hastings, Johns Hopkins Univ., Baltimore, Md.

April, 1880.

Prof. Bailey's apparatus seems to be most admirably adapted to its purpose.

C. S. HASTINGS.

From Prof. Richard A. Proctor, A. M., Ph. D., F. R. A. S.

I have seen Prof. F. H. Bailey's Astral Lantern and carefully examined all its details. I consider it most admirably adapted for the purpose of teaching the student of astronomy the true position and movements of the stars. In fact, I can truly say I have seen no contrivance even approaching it in value in this respect.

RICHARD A. PROCTOR.

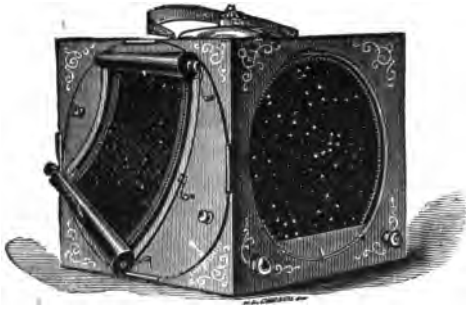
What a Poet Wrote on Seeing the Astral Lantern.

STUDYING THE STARS.

There lay in the Scottish meadows,
  A wondrous clear-eyed lad,
Wrapped up in midnight shadows,
  And the folds of a shepherd's plaid;
Lay long, and eagerly gazing
  With wonder—straining eyes
At God's own jewelry, blazing
  Upon the stately skies;
He looked in the stars' sweet faces,
  They fed his nature's needs—
He marked their glowing places
  With strings of glistening beads.
To the fame his soul ne'er doubted,
  His quick brain drove him on,
Till the world with honor shouted
  The name of Ferguson.

But now, when youth's mind-vision
  Would range the mystery-sky,
Pale Science's strange precision
  Has mapped it for his eye;
And captured the stars in cages,
  And mocked their flickering flame;
Subdued these kings of the ages,
  And made them come by name;
On earth the stars are brightening,
  Brought down from clouds of space,
As Franklin drew the lightning,
  And gave it useful place;
And the Scotch boy's spirit, turning
  From new-found stars above,
Looks down on this glow of learning,
  With smiles of pride and love.

—*From the N. E. Journal of Education.*



Bailey's Astral Lantern.

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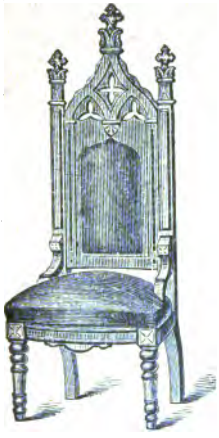

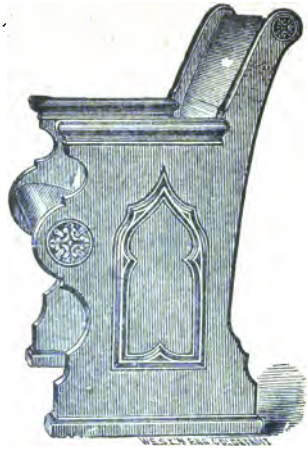

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